

Ilkka Tikanmäki, Jyri Rajamäki & Rauno Pirinen (eds.)

Mobile Object Bus Interaction

Designing Future Emergency Vehicles

Samples of Evidence Series: Volyme 3

Mobile Object Bus Interaction. Designing Future Emergency Vehicles

“Are emergency service vehicles packed with too much equipment?”

“Why can’t vehicles’ ICT applications be simplified and rationalized to help first responders work more efficiently and effectively?”

“Can two items of equipment be combined to make it easier to use and decrease power consumption?”

The MOBI (Mobile Object Bus Interaction) research project aims to create a common information and communications technology (ICT) infrastructure for all emergency service vehicles based on better integration of ICT systems, applications, and services. Our approach is to divide emergency service vehicles’ ICT systems into four layers (a vehicle infrastructure and power management layer, a communications layer, a service platform and common services layer, and an actor-specific services layer) with standardized interfaces between them. Open standards make it easier for small- and medium-sized enterprises, in particular, to enter the market. In addition to providing cost savings, our system significantly improves interoperability and the availability of new ICT services for first responders.



LAUREA JULKAISUT | LAUREA PUBLICATIONS

ISSN 2242-5241 (PRINT) | ISBN 978-951-799-297-8 (PRINT)

ISSN 2242-5225 (ONLINE) | ISBN 978-951-799-334-0 (ONLINE)



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Technical editor: Ilkka Tikanmäki (body text)
& Tarja Laakkonen (cover)

Cover picture: Tapio Mäkinen

ISSN-L2242-5241

ISSN 2242-5241 (print)
ISBN 978-951-799-297-8 (print)

ISSN 2242-5225 (online)
ISBN 978-951-799-334-0 (online)

Edita Prima Oy, Helsinki 2014

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Foreword – Designing the Future Emergency Vehicle

Are emergency service vehicles packed with too much equipment? Many think so, which is why a research project set out to find ways to simplify things.

MOBI – Mobile Object Bus Interaction Research and Development Project was a three year research project involving collaborative work between Laurea University of Applied Science, the technical center of the Finnish Police, who were the initiator of the project, and diverse industrial partners such as Airbus Defence and Space (formerly, Cassidian); Ajeco (security electronics and software company), Sunit (in-built vehicle computers and display company), and INSTA (IT service provider for public safety in Finland).

Police officers and emergency service workers are gaining more ICT facilities and applications in their vehicles, and many are asking why these cannot be more rationalised so work would be easier and more efficient and effective. Could two items of equipment be combined into one to make it easier to use and decrease power consumption, for example?

This was the major goal behind the MOBI project. MOBI aimed to create a common international ICT infrastructure for all Public Protection and Disaster Relief (PPDR) vehicles, based on better integration of ICT systems, applications, and services. Another aim was to extend this project to other PPDR vehicles in European countries, permitting the standardization of tools and technology in EU countries.

Usually, a police vehicle is a generic car with added features. As the need to transfer data grows exponentially, the number of electronic devices, cables and user manuals that need to be carried also increases, eating more and more into available space. The devices, cables and user manuals are rapidly becoming unmanageable. This trend can only continue to accelerate, because emergency workers need to have fast transfer of photos, videos and heavy documentation between the different units, combined with strong network security.

The beauty of the MOBI project was that it researched its topic in practice. A demonstration vehicle was first specified and then it was used for tests and further research by the project members.

Finnish public safety organisations have the unique ability to innovate and develop new methods and solutions in cooperation with each other. Laurea's research projects such as

MOBI add the students of applied sciences as well as cooperative business partners into the equation. As an idea and as a process, this is a great thing.

In the scope of such a cooperation project, people representing businesses and people representing their customers or prospects can discuss topics very openly. This is incredibly important. The business partners have a great opportunity to learn, to be able to design solutions for Finnish and international public safety customers alike.

Airbus Defence and Space believes in the importance of providing digital services and secure communications and the MOBI project offered a way to become ever more innovative in safety and security.

Helsinki 25.2.2014

Tiina Saaristo
Head of Content and Strategy Airbus Defence and Space



Preface - Security with Greater Situation Awareness and Connectivity

Laurea University of Applied Sciences has built in only few years a good portfolio of national and European security research projects. It has good contacts to end users from east of Vaalimaa to Texas, Alaska and Hawaii. Projects have included topics such as GPS tracking, border control, the police and other first responders, and technologies such as micro UAV's. The projects have been tackling technical issues, human factors and legal aspects of security.

This publication contains the results of “Mobile Object Bus Interaction” (MOBI) project in Tekes' Programme for Safety and Security (2007-2013). MOBI deals with a police vehicle with extensive amounts of electronics, a test bed of current and new technologies. This research project generated data for industrial projects by especially studying the needs of the end users and possibilities for standardization. Key demand is the interoperability between the vehicles and their control centers. These aspects were tested using a demo vehicle with working ICT-integration.

The trend is towards the mobile police office giving the police on patrol more accurate situational awareness thus improving operational efficiency and giving more service for the society. More smart technology in police or other emergency response vehicle is likely to create new technical problems on how the different electronic systems work together and how larger amounts of data can be securely transferred. In some countries police now use private smartphones to bypass such problems, thus creating new security risks. Day to day operations are increasingly dependent on ICT systems, especially on wireless and mobile communications. Thus there is a need to find working solutions in a given price range.

The ICT-systems should be easy to use and available all the time, thus improving policeman's or policewoman's efficiency in work. Many technologies, e.g. mobile video surveillance, help to record the actions of the police or the suspects, accident location etc. – they create data that is useful in further legal etc. processes. However, the payback on investments is often hard to quantify.

The European Commission, the European Law Enforcement Agency (EUROPOL) and the European Agency for the Management of Operational Cooperation at the External Borders (FRONTEX) have all recognized that the lack of interoperability of technical systems limit the effectiveness of operations. Gaps in technologies or the less than perfect connectivity to other technologies exist: e.g. in locating of resources, real time monitoring, analyzing data, even reporting. There is no unified platform on which to build the vehicle's ICT-systems – maybe the root cause of interoperability problems? There is not much standardization in this field in Europe; every country has its own requirements. Voice communication is still – for many good reasons – the primary way of communicating. But the limited amounts of data that can be sent or received with current systems are a limiting factor; compare e.g. TETRA/TETRAPOL and 3G or 4G. Issues like information sharing have also organizational and legal problems between various security authorities. In the end the police on the field want incident support and easier reporting, smooth communications, access to relevant data. Currently not even the power consumption of the electronic systems versus car battery capacity do not match well.

To some extent similar technologies are used at e.g. airports in automatic passenger control (ABC) in border crossing. Use of robots, e.g. unmanned aerial vehicles (UAVs), is one technological option in surveillance. Laurea have studied also these aspects. For example the European Commission FP7 Security and the just starting Horizon 2020 Secure Societies programmes study issues of cultural customs, facial and other biometric recognition, biological, chemical and explosive sensors, telecommunications etc. MOBI-project was linked to e.g. European Commission FP7 Security project “AIRBorne information for Emergency situation Awareness and Monitoring” (AIRBEAM), “Project Policy-oriented marine Environmental Research in the Southern European Seas” (PERSEUS) and “Scientific innovation Product concept” (SCOPE), and also key companies' own projects. Such international collaboration is more important now when the Tekes security research programme has ended. At the moment cybersecurity is on the rise nationally and globally. European Commission is increasing its role in security research also through its executive agencies. It is important to see European, and even American and Russian, developments in security.

From developing technologies and testing of new technologies, even in large scale demonstration projects, there is a long way to successful operational use of the technologies in the field. Procurements starting from specifications to selection of contractor teams and delivery of hardware and software often take many years, during which some of the technologies may become obsolete. The MOBI case touches also the issues of public procurement. An old English saying says “Don't buy anything Mark I.” But at the same time it is seen that public procurement can foster innovation.

The law enforcement wants usable systems and individual equipment that are added to the system in the police vehicle. Also in Finland the public procurement laws are changing to enhance the quality of procurements. The new laws may 2016 onwards help Finnish SME's in competitions. Similar changes are on the way in the European Union level, the new directives should be ready by the end of this year. Also the Framework Programmes FP7 and

Horizon 2020 have project types “Pre-commercial procurement” (PCP) that prepare development future technologies for public procurements.

The publication describes also relevant other studies by Laurea, especially by its students and graduate students: e.g. on fire engines electrical devices, TETRA mobile radio and onboard computer integration with touch screen based user interface, patient contentment in the quality of first-aid services, usability of paramedic reports, renewing of police Information System, tablet computers and smartphones in healthcare, opinions on the use of the Virve-network, utilization of RFID-technology, utilizing video surveillance to support police.

Linking the research by students for Bachelor’s and Master’s thesis to the portfolio of larger research projects is an especially good approach.

Helsinki 25.2.2014

Pauli Stigell
Senior Adviser
Tekes

1 Introduction

Jyri Rajamäki, Pasi Kämppä & Rauno Pirinen

The Mobile Object Bus Interaction (MOBI) Research and Development Project has been an essential feasibility study towards designing future vehicles for safety authorities and other public protection and disaster relief (PPDR) actors. These vehicles might be dedicated emergency response vehicles (ERVs) for first responders (FRs) or specific mobile command and control centres and offices for public safety officials; however, in Finland these functions are often combined within one vehicle. The following two abstracts by the project's research director, Dr Jyri Rajamäki, introduces the project.

Rajamäki, J. (2013a). *The MOBI Project: Designing the Future Emergency Service Vehicle*. *IEEE Vehicular Technology Magazine*, vol.8, no.2, June 2013, 92-99.

Abstract: The proliferation of information and communications technology (ICT), facilities in public protection and disaster relief (PPDR) vehicles has highlighted several questions, including: "Why can't vehicles' ICT applications be simplified and rationalized to help PPDR responders work more efficiently and effectively" and "Can two items of equipment be combined to make it easier to use and decrease power consumption" Our project aims to create a common ICT infrastructure for all PPDR vehicles based on better integration of ICT systems, applications, and services. Our approach is to divide PPDR vehicles' ICT systems into four layers (a vehicle infrastructure and power management layer, a communications layer, a service platform and common services layer, and an actor-specific services layer) with standardized interfaces between them. Open standards make it easier for small- and medium-sized enterprises (SMEs), in particular, to enter the market. In addition to providing cost savings, our system significantly improves interoperability and the availability of new PPDR ICT services.

Rajamäki, J. (2013b). *Future Emergency Vehicles' ICT Services*. *Invited Plenary Lecture. Recent Advances in Computer Engineering Series*, vol. 16: *Proceedings of the 2nd International Conference on Information Technology and Computer Networks (ITCN '13)* edited by Sergio Lopes, p. 15, WSEAS Press

Abstract: Public Protection and Disaster Relief (PPDR) responders' emergency vehicles are packed with ICT facilities. This lecture shows that vehicles' ICT systems can be simplified by dividing ICT architecture into certain layers (e.g. vehicle infrastructure and power generation layer, communications layer, common services for all PPDR actors' layer, specific services layer) that have standardised interfaces. PPDR vehicles' communications needs can be divided into long distance communications (e.g. TETRA/TETRAPOL, 2/3/4G, FM, GPS, WiMAX), local area networks (CAN, LAN, WLAN, ad-hoc –communications between vehicles) and accessory communications. Furthermore, each category is scaled from light to heavy. ICT solutions have to be robust, easy to install and a special attention has to be paid to information security. Different encryption methods between different kinds of systems bring their own challenges. In addition, different PPDR actors have their own requirements how to implement the information security into their vehicles' systems. The standardised communication layer for all PPDR organisations enables co-operation between authorities, e.g. via common talk groups. The next harmonising pitch will be the common services for all PPDR actors' layer. This includes a field command system for all PPDR actors being a complete solution that integrates different applications into one easy-to-use interface. The same technology and application can be applied by all PPDR responders.

1.1 Background of the MOBI Project

PPDR services, such as law enforcement, firefighting, emergency medical, and disaster recovery services, bring value to society by creating a stable and secure environment. The protection to be ensured by PPDR responders covers people, the environment and property. It addresses a large number of threats, both natural and man-made. One important task of PPDR services is to deal with emergency and surveillance situations on land, sea and air. The most important part of this work is done in the field, so all the tools must match the needs accordingly. When working in the field, vehicles with their devices, systems and the services they provide are the most important tools, in which occupational safety, efficiency and ergonomics must be taken into account. The vehicles used and devices installed on them must be robust, secure and suitable for very demanding and variable conditions.

The number of technical devices, applications and services in emergency response vehicles (ERVs) has increased during the past few decades. This progression has also increased the volume of different user interfaces and generated new problems, e.g. vehicle airbags have less room to fill. Technical problems, especially with power consumption and cabling, have also been reported.

Another problem is the poor documentation of applied solutions because there has been no standardization in the field. This is partially because of the diversity in equipment and the vendors who supply them. The diversity in the equipment supplied raises issues of system integration and interoperability between collaborating units, such as the emergency control unit or the command control with the emergency vehicles in the field. The issue of

interoperability also negatively impacts the administration of the emergency services since services are observed to be managed on a national, regional and local basis. Information interchange is therefore critical. For instance, in the fire and rescue service field in Finland, the country is divided into multiple regions, where each of those regions have their own fire and rescue departments responsible to deliver fire and rescue services to the public. As the technology develops and becomes more utilized in everyday life, so it does in the fire and rescue environment. These technology advancements would help to develop services, make them more efficient and especially help the rescue services unit to better deliver effective and efficient service. Unfortunately, so far there has been no standardization in the equipment and systems utilized by these emergency service vehicles. The number of equipment suppliers is large and complex. Yearly low delivery volumes have not been helping the development of standardization. The aforementioned problems present the need for new business models.

Moreover, with the increased number of applications, the amount of transferred data has exploded. In the field, the role of wireless communications is to support the mobility of first-time responders by providing continuous connectivity among responders and with the command and control rooms. The support includes: maintain voice communication to coordinate the relief efforts for the resolution of the crisis; creation and distribution of a common operational picture among all responsible parties; collect and distribute data on the operational context or the environment from sensors; retrieve data from central repositories (e.g. building plans, inventory data) to support their activity; and support the tracking and tracing of the supply chain of goods and materials needed in the response and recovery phases of a crisis.

In Europe, many dedicated and secured network infrastructures have been built and deployed to provide the necessary capabilities for PPDR organizations. These networks, generally realized by TETRA/TETRAPOL are narrowband. The lack of broadband connectivity of wireless communications for existing and future PPDR applications is a real problem (Baldini, 2010). Many new applications require wideband or broadband data rates usually provided by commercial operators. For that reason, separate parallel data communication channels are needed.

The European Commission, the European Law Enforcement Agency EUROPOL and the European Agency for the Management of Operational Cooperation at the External Borders FRONTEX have recognized that lack of interoperability limits the effectiveness of PPDR practitioners in actual operations, and an evident lack of understanding as to whether these limitations arose from technology, operational procedures, gaps in procurement or research (Baldini, 2010). A scientifically proven fact is that standardization strongly affects businesses that develop and sell technologies and technology-based products and services; standards are one main enabler for fast growth (Kivimäki, 2007). For improving interoperability, standardization development among like-minded countries should be started.

PPDR field operations are increasingly dependent on ICT systems, especially wireless and mobile communications. In PPDR vehicles, data communication is mission-critical. It is

necessary to ensure that information and “on-demand” services provided by these technologies are delivered reliably and securely through one or more of the recently developed wireless architectures.

According to Baldini (2010), the main effort in developing ICT systems of PPDR should be to standardize the interoperability architecture for applications (e.g. command and control) and infrastructure (e.g. interface gateways, mobile unit). Usability is also a main concern, as many solutions are not ergonomic or easy to adapt to existing vehicles or infrastructures.

1.2 MOBI Programme and MOBI Project

The target of a Finnish national research, development and innovation programme ‘Mobile Object Bus Interaction (MOBI)’ was to make essential feasibility studies towards a common ICT hardware and software infrastructure for all emergency vehicles. This information infrastructure (II) includes devices for voice and data communications, computers, screens, printers, antennas, and cables; and in addition, interlinking with factory-equipped vehicles’ ICT systems is researched.

The programme consists of two industrial projects and a research project that generates research data for industrial projects by researching and documenting the needs and requirements of the users, power generation and supply, and specifying the existing solutions. One industrial project, led by Cassidian Finland Ltd., implemented a vehicle-installed professional mobile radio concept for law enforcement, fire and rescue operations. Another industrial project, led by Insta DefSec Ltd., developed secured software services. The project utilized the results of the related research project and aimed to develop product concepts that have potential in both domestic and export markets. Additionally, Insta DefSec Ltd. further developed its business model in order to be able to utilize the growth potential of the product concepts.

The MOBI research project generated research data for industrial projects by researching and documenting the needs and requirements of the users, power generation and supply, together with specifying the existing solutions. The research also investigated how SOA and Web services standards can support the software application requirements of these vehicles in order to enable standardization, integration and interoperability between the vehicles and their control centres. Based on the research, a demo vehicle with working ICT-integration was equipped.

The project consortium, led by Laurea University of Applied Sciences, consists of three research institutes, two industrial partners, two small- and medium-size enterprises (SMEs), several end-user organizations and a public financier: Tekes — the Finnish Funding Agency for Technology and Innovation. The budget of MOBI research projects is €800,000 and Table 1 shows the funding shares.

Table 1 Funding for the Mobi research project.

Participant	€	%
Tekes	480 000	60
Research institutes	129 000	16
Industrial partners	110 000	14
SMEs	42 000	5
End-users	39 000	5
TOTAL	800 000	100

Fig. 1 shows MOBI’s Work Packages (WPs). The project starts by researching user requirements (WP2). The common ICT infrastructure is composed of four layers and their standardized interfaces: vehicle ICT infrastructure and power generation (WP3), data communications (WP4), common software infrastructure (WP5), and ICT services for PPDR practitioners (WP6). Also, a demo vehicle is equipped (WP7), new business models studied (WP8) and coordination taken care of (WP1).

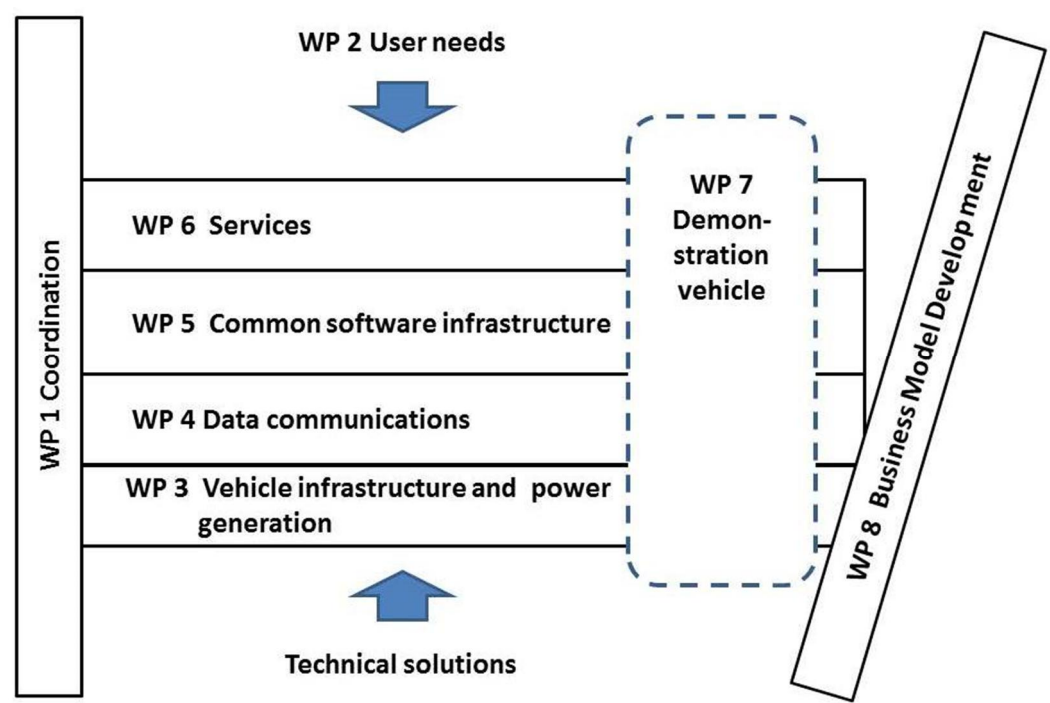


Figure 1 Work Packages of the MOBI project.

Work Package 1 included tasks considering project management, of which the main objective is to ensure that the MOBI research project generated research data for the parallel corporate projects. This work package included cooperation and the exchange of information with other relevant projects, such as the MOBI project's parallel corporate projects, EU FP7/SEC Project AIRBorne Information for Emergency Situation Awareness and Monitoring

(AIRBEAM), EU FP7/SEC Project Policy-oriented Marine Environmental Research in the Southern European Seas (PERSEUS), Scientific Innovation Product Concept (SCOPE), and CELTIC Plus Project Multi-Agency Cooperation in Cross-border Operations (MACICO).

In Work Package 2, present electrical and ICT systems were surveyed (for example for police vehicles: power supply technologies, radio equipment, video equipment, radars and other speed-monitoring devices, IT workstations, printers, biometric devices, and navigation and tracking devices). User and authority requirements for these systems and devices were also surveyed. Former studies (e.g. RIESCA and SATERISK) were used as a source for information. In this work package, administrative and operative systems were identified and priority and manageability requirements for these systems were defined.

Work packages 3 through 6 dealt with technical aspects. WP3 concentrated on vehicle infrastructure and power management, WP4 data and voice communications, WP5 service platform and common services, and WP6 on actor-specific services. In Work Package 7, a demo vehicle was equipped, and industrial participants and end-user organizations were able to test chosen solutions in this restricted research environment.

Developing an ICT concept is expensive, so access to the international markets is desirable. Finland is an optimal country in which to develop the industry because cooperation between different authorities is efficient and highly developed. The challenges mentioned in Section 1.1 are similar in all countries and much needed standardization has not been introduced in the industry. Work Package 8 studied these standardization issues. Also, industry's market and volumes, and national and international public-private partnership regulations were studied in WP8. One of the main tasks was to monitor the development of markets in this industry within the EU. WP8 also researched how PPDR organizations should choose their service delivery models for new digital services.

1.3 Layered Approach to ERVs' ICT Integration

The MOBI project's approach was to divide ERVs' ICT systems into four layers that have the standardized interfaces shown in Figure 2. These layers are (1) a vehicle infrastructure and power management layer, (2) a communications layer, (3) a service platform and common services layer, and (4) an actor-specific services layer. Some aspects run through all layers, such as security, power efficiency and product safety regulations.

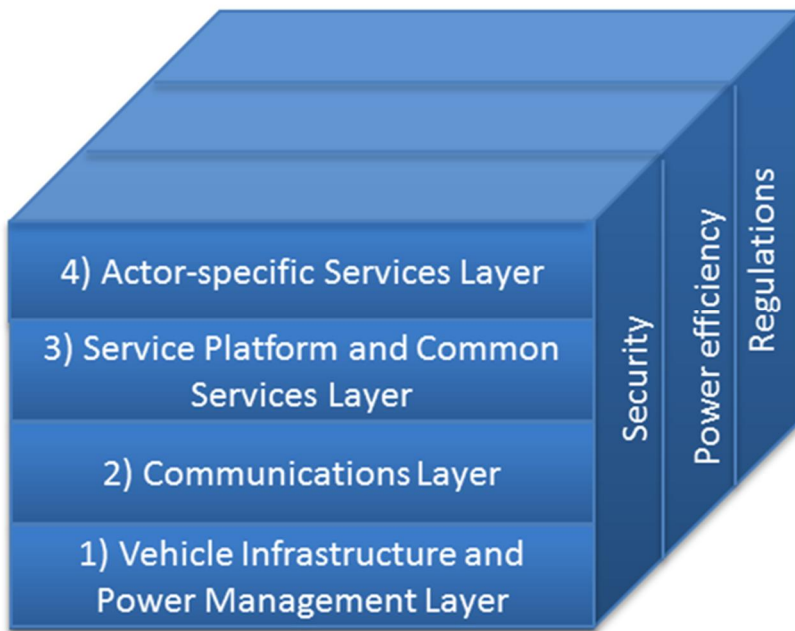


Figure 2 Layered approach.

With regard to the vehicle infrastructure and power management layer, there are two main areas to standardize: (1) what services will be adapted from a standard vehicle system; and (2) how to make the car body modifications and new installations in a standardized manner. The services adopted from standard vehicles include, for example, power generation when the engine is on and information applied from the vehicle's controller area network (CAN). The standardized ERV installations include vehicle body modifications, emergency lights and alarms, intelligent power management (power generation, storage and distribution systems) as well as cable and antenna installations (electromagnetic compatibility issues).

In the current digital world, FRs are aware of the benefits that interconnection between different professional mobile radios (PMR) and the integration of new advanced data services could bring to their professional sectors. LTE is considered an appropriate technology for building next-generation broadband public safety networks. However, it does not yet support some voice communication characteristics that PMR technologies already offer. Also, PMR systems are widespread around the world, making their replacement quite difficult within a short period. Therefore some public safety organizations are working on dual solutions to provide TETRA voice capabilities, together with broadband data transfers.

All ERVs have many similar applications, such as a navigation system, patrol tracking, target maps, activity logs, alarms and remote access to central databases as well as the control of blue lights and sirens, power supply systems, and communications equipment. Roughly, the common needs of the service platform and common services layer could be divided into two main areas: (1) a decrease in the number of physical human-machine interfaces (HMIs); and (2) a common field command system for all PPDR actors that also improves interoperability between different FR actors. However, several physical HMIs are needed for different modes

of operation. For example, the HMIs when driving at full speed should be totally different from those in a mobile office mode, where ergonomics have an important role. Applying the design principles of service-oriented architecture, from an end-users point of view, different existing systems will seem to form one part of the field command system.

By 'actor-specific services', we mean these digital services that differ substantially from other FR needs. For example, LEAs ought to have forensics technology for investigations and field work. These kinds of technologies include advanced tracking systems that apply the Global Positioning System (GPS) to track criminals and vehicles that have been tagged. This allows LEAs to keep track of suspicious activity that can help solve cases. However, these digital services should run on top of common services via a standardized interface.

1.4 Research Methodology

The MOBI research was addressed to the field of emergency vehicle based solutions and applied mobile technology in an authority and emergency management environment. It involved the kinds of applied technologies that advanced solutions and new emergency mobile systems sharing that was first addressed on the national level and then targeted to global dissemination. The MOBI accepted new technical emergency equipment and digital services mainly in the field of emergency automobiles; the MOBI research was addressed to novel problems such as power supply, ergonomics, cabling route, electromagnetic compatibility and the functioning of safety devices from the perspective of emergency vehicle related systems and management functions.

The MOBI study included the R&D framework, which comprised a continuum of R&D methods for increased understanding, and for building, improving and testing information-intensive services artifacts, which were relevant both to the MOBI research and to the research strategy and R&D agenda at Laurea UAS. The research rationale facilitated settings which were related to the integration of the MOBI project and activities of higher education functions, such as authenticity, emerge value, expertise networking and valuable relations between MOBI actors. Following from this, it was possible to understand a single R&D intervention in MOBI as part of a larger collaborative network of R&D interventions and global knowledge transition, collocation, scalability and dissemination.

For students' centred thinking and the scope of research evidence in integrative model, the MOBI was identified as the integrated mobile-based research theme of emergency vehicles which then were mainly addressed to the information systems, safety domain and service studies in the education functions within the research collaboration and towards the MOBI network. Here, the R&D interventions were performed in a manner that integrates students and networks of related R&D actors; therefore, such interventions would take place in integrative environments, such as a MOBI research consortium, that allow dissemination and globalization of new knowledge and in which knowledge transition and distribution is both used and focused upon.

The integrative R&D model of MOBI builds bridges between technologies, applications and services. It enables research results to be transformed into products and services, and it creates economic value returns among involved actors, such as related test environments, regional innovation systems and more global business actors. In the MOBI, it was understood that innovation alliances should be made between various stakeholders, particularly in science, business, and especially here as between politics and policy-based actors.

In the R&D model of MOBI, vertical cooperation, namely lead innovations, was geared toward certain services, applications and branches that benefit from specifically coordinated support from mobile emergency technological domains. In collaboration with service platforms, technological alliances and technological objectives were jointly created by science and solutions as well as aims of global business. Since the realization of study units included different types of future sense, which can be described by such relative new terms as “proactive, cooperation, co-design, co-creation”, reflection and research activities.

Laurea’s role in this “lead innovation mobile system” was focused upon emergency service product innovations and the production of professional competences. In this integrative R&D model, the term “co-creation” as an activity of “mutual creation” pertains to an R&D collaboration, in which students and customers can be seen as “co-creators” of emergent values and information rather than as passive recipients of learned knowledge, goods and technology-based services. For this new cultural change, the MOBI research focuses on “co-created” knowledge and “co-designed” products and services by encouraging the development of competitive “value co-creation” in the fields of safety, service and emergency-based mobile product development.

The one noteworthy methodological contribution of MOBI was the facilitation of a linear R&D framework and design for cyclic innovation activities that have research, action and quality returns. The system was a kind of “co-work system” within an innovation system framework and as a liberation process for innovative activities — support for knowledge-building rather than a fully automated process for innovation generation. (Cf. Alter, 2008.)

In the MOBI studies, where the next methodological reflection was concerned, was in the collective interpretation of related knowledge sources, technological elements and mobile solutions. The reasoning for the continuum of MOBI methods lies in the assumption that the MOBI consortium and activities of R&D-related higher education studies emerges value, knowledge economy, expertise networking, value returns and relationships for involved actors (Pirinen, 2008).

In MOBI, the view of rigorous research was approached to be as a prerequisite for the sustainable developing and quality of networked expertise. In this context, the framework of the research continuum included: (1) thinking and idea-building groups as co-creation forums; (2) case study research for understanding; (3) design research for building, improving and testing artifacts, services and methodology; and (4) a “last-mile research” approach for general utility production, which in the end is addressed to value-building and economical returns on the national and global level.

First, in MOBI the participants were involved in collaboration models in which achieved value comes from physical goods and artifacts but also increasingly from intangible things such as services, focused knowledge, and global relationships. In this shift in new emergent knowledge and the business model, the first empiric view can be compressed to the phrase “MOBI was research for transition to live”, customers, and the role of higher education would be seen as “co-creators of value” rather than as passive recipients. This first knowledge-sharing dimension can also be described in more general terms as “thinking or idea-building space” or then as a “co-creation forum for pre-validation and synthesis of promising proposals for transition to live”.

Next in MOBI, case study research was co-instructed for bringing an understanding of a complex issue or object, and it can extend experience or add strength to what was already known through previous research. The implementation of case studies in MOBI emphasised the detailed contextual analysis of a limited number of events or conditions and their relationships, except when the relevant behaviour cannot be changed or manipulated by researchers (Eisenhardt, 1989; George & Bennett, 2005; Gerring, 2007; Stake, 1995; Yin, 2009).

In MOBI, the case study inquiry relies on multiple sources of evidence, with data needing to converge in a triangulation fashion, and it benefits from the prior development of theoretical propositions to guide data collection and analysis. The term “triangulation” here refers to the usage of multiple sources of evidence such as: data sources, as data triangulation; among different evaluators, as investigator triangulation; perspectives of the same dataset, as theory triangulation; and multi-methodological approach, as methodological triangulation (Campbell & Fiske, 1959; Nunamaker, 2010; Patton, 1990; Robson, 2002; Yin, 2009).

Then, third in the MOBI research continuum, design research studies were considered to produce a viable and mobile artifact in the forms of a construct, model, method, or instantiation, and design science produces design science knowledge for the improvement of the activities of design and construction. In other words, in the MOBI study, it produces the knowledge to implement and realize the emergency-related artifacts, services, methods and incipient innovations (Alter, 2008; Gregor & Jones, 2007; Hevner, March, Park, & Ram, 2004; Hevner & Chatterjee, 2010; Markus, Majchrzak, & Gasser, 2002; Simon, 1996).

Finally, probably the most reflective study efforts were concerned with the multi-methodological view of research and learning. Here, our understanding was that because no particular research methodology should be regarded as the pre-eminent research paradigm, and because no particular research methodology is sufficient by itself as stated in Nunamaker, Chen & Purdin (1991). Following Nunamaker (2010), the focus of R&D outcomes of MOBI and evaluation would be in the prediction of research impacts, e.g. by way of using last-mile research, which includes three phases: proof of concept, which is close to the exploratory sciences; proof of value as the view in experimental sciences; and proof of use as an instance of applied sciences and engineering.

1.5 Learning Achievements and Dissemination

Research, development and innovation are central and essential part of the activities of higher education institutions. Student-centric R&D&I, where students are in a central role generating and managing R&D&I and creating innovations and solutions, is still rare. The future vision is genuine student-driven R&D&I in which Laurea is a pioneer. The study of Laurea's student Timo Villemson concentrates on the planning and preparation phases of the MOBI project.

Villemson, T. (2011) User centric research in the MOBI-project. In O. Kallioinen (Ed.) Learning by Developing-New ways to learn. Proceedings of the 3rd Conference on Future Expertise in Higher Education, Vantaa: Laurea University of Applied Sciences, 144-157.

Abstract: This study takes a look at the output from 2009 autumn's student centric research work concerning Mobile Object Bus Interaction (MOBI) project and looks at the methods the students used. Then the output and methods will be looked at from the point of action research and how action research can improve the output of Laurea's future projects. The MOBI project was started in Laurea in multiple fronts as different kinds of research projects. These projects include subjects like biometrics, taxonomical research on services, CAN-bus etc. Laureans LbD (Learning by Developing) model gives its students a great level of freedom to conduct research and the same goes for the MOBI project. Laurea provides the students a subject, resources, guidance and a level of standards that they need to reach. And in exchange for this freedom, students produce a wide variety of innovation made with genuine interest.

Students from Laurea University of Applied Sciences participated in many MOBI-related work packages and completed over 1,000 credits with their project work. Two joint projects were organized with the Metropolia University of Applied Sciences and Aalto University, where students had the possibility to work in an authentic environment as MBA Pasi Kämppi presented in the TIEMS (The International Emergency Management Society) workshop.

Kämppi, P. (2013). Living Lab implementations in the MOBI project. TIEMS Workshop on Smart Environments and ICT Systems Living Lab for Societal Security, 26-27 September 2013, Espoo, Finland.

Abstract: Emergency vehicles are nowadays more like mobile offices that carry a lot of equipment and ICT-technology. Finnish police patrol vehicle has over 40 user interfaces and energy peak consumption can be almost 200A. Laurea University of Applied Sciences (UAS) started the MOBI project on 2010 to find solutions existing problems by theoretical research and practical implementations with proof-of-concepts. Laurea UAS got a real van-sized police vehicle from the Finnish Police as a research platform on 2012 and started to find solutions by implementing proof-of-concepts after intensive theoretical research phase since 2010. The real police vehicle provided a very interesting learning environment for lecturers, researchers,

students and partners. The most successful proof-of-concepts were multi-channel routing telecom proof-of-concept, new intelligent battery system proof-of-concept, touch screen based TETRA-terminal proof-of-concept and RFID-based equipment tracking simulation in emergency vehicle. All these proof-of-concepts were implemented and verified in authentic learning environment in the real police vehicle. The presentation will cover four already implemented proof-of-concepts and one proposal for a new research item.

Students had the possibility to participate in national and international seminars where they could interact with top experts in the field. The MOBI seminar in May 2013 included ten student presentations, and the following students presented their papers at scientific conferences:

- Timo Villemson at of the 3rd Conference on Future Expertise in Higher Education, October 12-15, 2010, Espoo, Finland.
- Taina Hult, Ilkka Tikanmäki and Tuomo Tuohimaa at the 10th WSEAS International Conference on Applications of Computer Engineering, March 24-26, 2011, Playa Meloneras, Gran Canaria, Canary Islands, Spain.
- Jouni Lehto and Jari Ahokas at the 11th WSEAS International Conference on Applied Computer and Applied Computational Science, April 18.-20, 2012, Rovaniemi, Finland.
- Jutta Tervahaltiala, Sofia Tervola and Sari Johansson at the European Intelligence and Security Informatics Conference (EISIC), August 22-24, 2012, Odense, Denmark.
- Markus Vuorinen at the International Congress on Engineering and Information (ICEAI), January 25-27, 2013, Bangkok, Thailand.
- Markus Vuorinen at the 27th International Conference on Information Networking (ICOIN), January 27-31, 2013, Bangkok, Thailand.

The Finnish Information Security Association awarded the Master's thesis of Jyri Penttinen as the best security-related thesis in the University of Applied Sciences series in 2013. Mr. Penttinen's thesis, "How to use different security-level IT service environments using the same data terminal equipment", aims to solve the challenges associated with different security-class service platforms used with the same terminal. The implemented solution allows different levels of the state administration of classified information safe and legal processing on the same terminal. This particular thesis topic is very current, and its usefulness is great — the work has already achieved significant cost savings. The thesis was made at the Laurea University of Applied Sciences and was evaluated as excellent.

In summary, there were 31 theses made: nine Master's theses at Laurea, one Master's thesis at Aalto University, and one Master's thesis at the University of the West of Scotland. Additionally, there were three doctoral dissertations done. Dr Rauno Pirinen from Laurea has made two project-related doctoral dissertations, and Dr Hanna-Miina Sihvonon from Emergency Services College has made her doctoral dissertation for the project-related issues.

The results were presented at international conferences, seminars and workshops; there were ten journal papers published and 25 peer-reviewed conference papers.

References

- Alter, S. (2008). Defining information systems as work systems: Implications for the IS field. *European Journal of Information Systems*, 17(1), 448-469.
- Baldini, G. (2010). Report of the workshop on “Interoperable communications for Safety and Security”. Publications Office of the European Union.
- Campbell, D. T., & Fiske, D. W. (1959). Convergent and discriminant validation by the multitrait-multimethod matrix. *Psychological Bulletin*, 56, 81-105.
- Eisenhardt, K. M. (1989). Building theories from case study research. *Academy of Management Review*, 14(1), 532-550.
- George, A. L., & Bennett, A. (2005). Case studies and theory development in the social sciences. Massachusetts: MIT Press.
- Gerring, J. (2007). Case study research principles and practice. Cambridge: Cambridge University Press.
- Gregor, S., & Jones, D. (2007). The anatomy of a design theory. *Journal of the Association for Information Systems*, 8(5), 312-335.
- Hevner, A. R., & Chatterjee, S. (2010). Design research in information systems: Theory and practice. New York: Springer.
- Hevner, A. R., March, S. T., Park, J., & Ram, S. (2004). Design science in information systems research. *MIS Quarterly*, 28(1), 75-105.
- Kivimäki, A. (2007). Wireless telecommunication standardization processes: actors' viewpoint. Oulu: Oulun yliopiston kirjasto.
- Kämppe, P. (2013). Living Lab implementations in the MOBI project. TIEMS Workshop on Smart Environments and ICT Systems Living Lab for Societal Security, 26-27 September 2013, Espoo, Finland.
- Markus, M. L., Majchrzak, A., & Gasser, L. (2002). A design theory for systems that support emergent knowledge processes. *MIS Quarterly*, 26(3), 179-212.
- Nunamaker, J. F. (2010). Interview with Jay F. Nunamaker: On toward a broader vision of IS research. *Business and Information Systems Engineering*, 5, 321-323.

- Nunamaker, J. F., Chen, M. & Purdin, T. (1991). Systems development in information systems research. *Journal of Management Information Systems*, 7(3), 89-106.
- Patton, M. (1990). *Qualitative evaluation and research methods*. London: SAGE Publications.
- Pirinen, R. (2008). Integrative learning environments in perspective of regional development. *Pascal International Conference, University of Limerick*, 1(28), 1-10.
- Rajamäki, J. (2013a). The MOBI Project: Designing the Future Emergency Service Vehicle. *IEEE Vehicular Technology Magazine*, vol.8, no.2, June 2013, 92-99.
- Rajamäki, J. (2013b). Future Emergency Vehicles' ICT Services. Invited Plenary Lecture. *Recent Advances in Computer Engineering Series*, vol. 16: *Proceedings of the 2nd International Conference on Information Technology and Computer Networks (ITCN '13)* edited by Sergio Lopes, p. 15, WSEAS Press.
- Robson, C. (2002). *Real world research (2nd ed.)*. Oxford: Blackwell Publishing.
- Simon, H. (1996). *The sciences of the artificial*. Cambridge: MIT Press.
- Stake, R. (1995). *The art of case study research*. Thousand Oaks: Sage Publications.
- Villemson, T. (2011) User centric research in the MOBI-project. In O. Kallioinen (Ed.) *Learning by Developing-New ways to learn. Proceedings of the 3rd Conference on Future Expertise in Higher Education*, Vantaa: Laurea University of Applied Sciences, 144-157.
- Yin, R. K. (2009). *Case study research design and methods (4th ed.)*. Thousand Oaks: Sage Publications.

2 User-centric Requirements

Paresh Rathod, Pasi Kämppi & Ilkka Tikanmäki

A research review of existing emergency response vehicles (ERVs) shows the implementation of services and solutions across various spectrums in normal conditions. However, a close encounter with real users of ERVs shows a shortcoming in various aspects, especially during varied conditions. Studies conducted in Work Package 2 (WP2) of the MOBI project emphasizes end-users' requirements and their needs in various conditions, including challenging conditions. Hence, considering their needs leads to better and sustainable services and solutions. Experts and real users of ERVs suggest that the area of improvement includes emergency response preparedness, critical communication and real-time updates, power supply optimization, availability of resources and equipment, safety and sustainability, ease of use and optimization of ICT systems. This chapter presents the outcome of extensive research work conducted mainly by students, researchers and project workers under the supervision of an academician and experts in the fields.

2.1 Introduction

The main deliverable of MOBI Work Package 2 resulted in an end-user requirements specification for standardization efforts for ERVs. For the article written by Paresh Rathod and Pasi Kämppi, they have extensively supervised research studies of students, researchers and project workers in the MOBI project. The document reflects the research reviews, analysis and outcomes in a standard format report. The report presents actual users' views and how they see things. The requirement-gathering, analysis and specification resulted in working closely with end-users. The popular requirements gathering techniques, such as interviewing police officers and users of Finnish ERVs, JAD* (among the R&D team), literature reviews and observation have been used to generate requirement specifications. Furthermore, both researchers have also published a research paper at one of the IEEE conferences in 2013 and the abstract presented below.

Rathod, P. & Kämppi, P. (2013). User Requirements of Emergency Response Vehicles: Preliminary Findings from a Current Research Study. In Proceedings of the 2nd IEEE International Conference on Connected Vehicles & Expo (ICCVE 2013), December 2-6, Las Vegas, Nevada, USA.

Abstract: A review of current Emergency Response Vehicles (ERVs) demonstrates the use of technological services and solutions in on- and off-pavement

performance. There is overwhelming usage of technologies including equipment, components and services in modern emergency response vehicles. These diverse elements also invite various challenges while building emergency vehicles. A set of standards has been released by local and global organizations to help building standard vehicle for emergency responses. There are effective implementations of these standards to provide services and solutions. However, research has shown shortcomings in current ERVs, especially in terms of real users' needs. Consideration of the user's needs and requirements has paramount importance for the building of effective and efficient Emergency Response Vehicles. This research paper addresses those gaps by reporting the preliminary findings of a current research project, namely Mobile Object Bus Integration (MOBI). The study has identified eight areas of focus by closely working with real users of emergency vehicles, which include emergency response preparedness, critical communication and real time updates, ease of use and optimization of ICT systems, optimization of power supply, availability of resources and equipment, and safety and sustainability. The end user's requirements were gathered using both qualitative and quantitative data analysis, and grounded theory-based research study. The focus of the preliminary findings is on the functional requirements. The paper also discusses the science used in the laboratory and field while building state of the art emergency response vehicles.

2.2 Factors Affecting the User Requirements Specification in Emergency Response Services and Solutions

In Finland, ERVs are in use by various authorities, including police, customs and border security guards, fire and rescues services, and medical emergency services. The ERV's space is mainly divided into two or three compartments. Various departments are building their ERVs based on their own requirements. That includes various products, services and solutions for each compartment. Various factors directly affect the gathering of user requirements and specifications for those products, services and solutions. Eija Lyytikä conducted her Master's thesis on the subject: "Impact of the Legislation of the Requirement Specification on the Log Management System: A Case Study Research in the Public Health Care Sector". The area of studies was a factor affecting information systems and security in ERVs. The study shows the need for in-depth research on every aspect related to emergency services. That indicated that various factors can affect the delivery of emergency services. Let us start exploring some factors by studying the abstract of Eija Lyytikä's research work.

Lyytikä, E. (2012). Lainsäädännön vaikutus lokienhallinta-järjestelmän vaatimusmäärittelyyn: tapaustutkimus julkisesta terveydenhuollosta. (The legislation impact on the requirement specifications for the log management systems design: Case study on the public health care sector) Thesis. Theseus. Espoo: Laurea(in Finnish).

Abstract: The main objective of this thesis was to examine the aspect of the legislation impact on the requirement specifications for the log management systems design in the public health care sector to be prepared for the implementation of the log management system for the public health care sector's information system on the required legislative level. In the thesis emerged a topical subject of the national health care information systems, i.e. the application of electronic prescription (eResepti), a part of the national public health care information system (KanTa-palvelu) in Finland. This application of the electronic prescription requires following the national audit requirements for log processing of public health care organizations. The implementing of the log management with the management system demands good design for the system in the public health care sector. An important factor for managing the log data is to understand the whole life cycle of the log data. The whole management, the definition of management and the implementation of management during the whole life cycle in the public health care environment should be comprehended.

The material of this thesis was gathered by theme interviews, observation and fieldwork in order to have versatile, rich and deep data. After collecting the data it was categorized by significance and entities of meaning based on the interview body. With this qualitative analysis method the purpose is to conceptualize the target of research and to discover concepts and rules of the law which allow the reader to realize and interpret what the research target really contains. Through the whole research process, collecting the material and the analysis are intertwined. During the research process there is interaction between the researcher and the research target, which also allows interaction between the researcher and the research field. This qualitative analysis aims to convey to the reader a realistic overview of the research target. The researcher avoids giving a too subjective description to the reader but instead aims to give a number of descriptions of the research target. With the qualitative analysis the researcher attempts to tell to the reader what was obtained through interviews, observation and fieldwork. The qualitative analysis does not aim at statistical representativeness. As a conclusion of this thesis it can be recognized that the log management is a part of overall information security and practices in the public health care organization. It would be necessary to define a log policy in the public health care organization, in order to define the roles and responsibilities, when the organization is drawing conclusions about the implementation of the log management system. The objective of this research was to conceptualize the research target, which was achieved.

Another research work was carried out by Tatu Urpila, a Bachelor's degree student in security management. His thesis work focused on investigating user needs for fire engine electrical devices and IT systems for volunteer firefighters. He has carried out observations, interviews and surveys to gather information. The study has been conducted to find out what electrical devices and systems help in information management, volunteer firefighters use in their vehicles during responding to emergency calls. Research work also explores

various factors affecting the results. The extensive details can be found in his thesis work. Nevertheless, a brief summary is presented below.

Urpila, T. (2012). Sopimuspalokuntien pelastusajoneuvojen sähkötekniset laitteet ja järjestelmät. (Electrical device and information technology in firefighting vehicles of volunteer fire departments). Thesis. Theseus. Espoo: Laurea (in Finnish).

Abstract: This thesis investigates user needs for fire engines electrical devices and IT systems of volunteer firefighters. This study is part of the first phase of the MOBI project research. To discover user needs, observing, interviews and a survey have been used to gather information. The information gathered using these methods has been supported by information from other studies and literature. This study has been conducted to find out what electrical devices and systems, help in for example information management, volunteer firefighters use in their vehicles during responding to emergency calls. This study mainly focuses on such devices and systems that are located in the crew cabin of the firefighting vehicles, for example, the control panel of emergency lights and sirens, communications applications and computers. This study does not cover firefighting gear or devices that are being used directly in firefighting. The results of this study reveal that volunteer firefighters have a great deal of different solutions in use. The number of devices that use electricity in the vehicles has caused some problems to the fire departments in managing the electricity supply. Some solutions for this problem have been presented; the most advanced model suggested is integration of different features in one device. The firefighters also have the need for more information technology for managing different types of information when responding to emergency calls. However, the firefighters also feel that information technology should also always have backup solutions. Based on the results of this study, the amount of information technology in firefighting apparatus appears to be growing and the users find it necessary.

A state-of-the-art PPDR organization keeps their mobile radio communication up-to-date to provide excellent services during a crisis situation. Ville Roisko, a Master's student from Aalto University conducted his research work on usability evaluation for the TETRA (Terrestrial Trunked Radio) mobile radio. Ville has been part of the research team in the MOBI project wearing the hat of a researcher (project worker). Pasi Kämppi, one of the chief researchers, has installed a Cassidian TMR880i TETRA mobile radio with a touch screen based UI in a demo vehicle. Ville carried out a usability evaluation on a newly developed graphical UI for the TETRA radio by Cassidian Finland Oy. It would be very helpful to know how users and their know-how from various PPDRs impact the optimum use of new services. There are various other factors explored by Roisko. These broaden scientific know-how on various factors affecting the core requirements of ERVs. The thesis work is considered as pivotal in the MOBI project, and hence an extended abstract has been included here.

Roisko, V. (2014). Usability evaluation of TETRA mobile radio in Public Protection and Disaster Relief (PPDR) vehicles. Master Thesis. Espoo: Aalto University (In Press).

Extended Abstract: This thesis concentrates on usability evaluation for the TETRA (Terrestrial Trunked Radio) mobile radio. In the demo vehicle of the project there is a Cassidian TMR880i TETRA mobile radio installed. Cassidian Finland Oy has also developed software for using the mobile radio from the screen of the onboard computer. The essence of this thesis is to answer to two fundamental questions: Is the new onboard computer integrated user interface (UI) of the TETRA mobile radio useful from the viewpoint of the end user? What are the main functions that should be included to the touch screen based UI of the TETRA mobile radio?

The software by Cassidian Finland is still a prototype and it has not been tested in moving vehicle before. At the moment the software includes a set of basic functions for operating the TETRA mobile radio. The main idea of the software is that the most commonly used functions of the mobile radio could be used from the touch screen and the actual mobile radio could be used to operate more demanding and less frequently used tasks. At this point of the product development process the main idea is to introduce the software to the end user and arrange usability tests and interviews in order to get the feedback and opinions from the end users. This way it is possible to design the best possible product for the users.

Usability evaluation process of the thesis has been divided in to three main areas. In the first phase three police officers were interviewed to get the basic information of the normal police work and the way they use TETRA in their daily work. The interviews were theme interviews. With the data from the interviews it was also easier to create more credible use scenarios to the usability tests.

Heuristic evaluation for the software was conducted after the interviews. In heuristic evaluation the UI is being examined with the help of certain usability guidelines. In this thesis the guidelines were based on heuristics by Jakob Nielsen. Heuristic evaluation is a method that can be arranged with small resources and can be used to find a significant amount of usability problems relatively easy. Heuristic evaluation fits with usability tests because methods find different types of problems and this way support each other.

After the interviews and heuristic evaluation usability tests with real users were arranged. The test session included a background questionnaire, set of test tasks and an interview. The interview had mostly the same structure than the three interviews in the first phase of the research process. The tests were arranged in the demo vehicle on public roads. Camera was installed to record the test situation to help the analysis of the results. The test situation consisted of ten test tasks including seven different functions of the software. Five users were tested, all of who were part of the actual TETRA mobile radio user group. As a summary there were in total seven interviews and five usability tests. It has been shown in different

studies that majority of usability problems can be found already with five test users.

In heuristic evaluation overall 42 different usability problems were found. The problems were rated with severities by Nielsen on a scale from zero to four. Majority of them (30 problems) were rated as two or three. In addition there were eight problems rated as four and four problems rated as one. All in all there are a significant amount of problems in the UI implementation and the usage can be occasionally quite demanding. Most of the problems can be easily corrected and therefore it is recommended to fix these problems in order to improve the user experience of the software.

Usability tests indicated that the software is relatively difficult to use while the vehicle is moving. The most important functions of TETRA mobile radio according to the users are talking, pressing the tangent and changing the talk groups. In the usability tests these were the functions that found out to be the most difficult to use. This means that in the following product development cycle it should be focused on improving the usability of these functions. Other issues that came out in the tests and interviews concerned the size of the number and letter buttons. In moving vehicle it found out to be quite difficult to hit the smallest buttons of the UI. This is also an issue that should be taken into consideration in the following product development phases.

Users had different opinions concerning the touch screen based UI for the TETRA mobile radio. Some did not see that the touch screen based UI would give any additional value comparing the current state in the vehicle. Others had more positive attitude towards the idea. Users are relatively satisfied with the current TETRA arrangements in the Public Protection and Disaster Relief (PPDR) vehicles and in many cases it is hard for them to understand why the current situation should be changed. It came clear though that some of the functions might be easier to use from the touch screen. Most users underlined that PPDR vehicles already have different systems operating on the onboard computer. Many of these systems include some of the same functions as TETRA for example status updates. At the end though majority of the users felt that the mobile radio could be used also from the touch screen. The solution would only have to be designed in a way that there is no need for switching between different applications on one screen.

Users had rather clear visions concerning the functions that should be included to the touch screen UI of the mobile radio. The most important functions are voice traffic, changing the talk groups, status updates, volume control and emergency call. These should be easy to use and clearly presented on the screen. Changing the talk groups is a function used extremely often at least in the metropolitan area. The users also underlined they want to see the number of the caller and the current talking group from the screen. Currently most of the mobile radio usage is still ordinary voice traffic and this is why it is crucial that the tangent is easy to use. The touch screen based tangent that can be found from the software is not perhaps the

best solution. The tangent could possibly still in the future be a separate physical button somewhere in the vehicle.

When interviewing the users it was noticed how different types of use cases different PPDR players have for the TETRA mobile radio. Interviewees were police officers and in addition one paramedic. Already with one interview with the paramedic it was easy to notice the differences compared to the police when concerning the usage of the mobile radio. In the light of this it is highly recommended to arrange usability tests and user interviews in cooperation with all the different PPDR players during the future research.

It is advisable to run full scale usability tests with the next version of the software prototype. These tests should include different kind of driving speeds and different kind of driving circumstances. It is extremely important that the software can be used fluently in all kind of situations. It has been planned that in the future a common field commanding system (KEJO) for all PPDR players will be introduced. It would be advisable to find out if there are possibilities to integrate the TETRA mobile radio UI to the field commanding system. Different applications for the field commanding system and the mobile radio have certain challenges at least with the current operating system Windows XP and limited 12" screen size of the onboard computer. In the future this can all change if the operating system and screens become more suitable. One option that may happen in the future is to include two screens to the vehicle where different applications can be divided. This would enable more effective use of the applications. In the light of the foregoing future development of both hardware and software of PPDR vehicles are in important role when concerning new kind of UI solutions for the TETRA mobile radio.

2.3 Emergency Response Vehicles (ERVs) and Quality of Service (QoS)

The build, services and solutions provided in emergency response vehicles are in direct proportion to the quality of customer services. Our previous paper broadly presented three types of ERVs: Medical Emergency Vehicles (MEVs), Police and Border Patrolling and Protection Vehicles, and Fire and Rescue Vehicles. Nursing students Emmi Sorsa and Rochelle Santos carried out an investigation on MEVs and provided a solution in their research studies. They conducted their studies in the rescue department of Kanta-Häme in the cities of Forssa and Hämeenlinna. The focus of study was divided into various themes starting from ambulance appearance, staff skills and method of treatments in MEVs. The result shows that patients were most satisfied with treatment at the scene and least satisfied with reporting to relatives. Complete details of the study can be found in the thesis titled, "Kanta-Hämeen pelastuslaitoksen Hämeenlinnan ja Forssan toimialueiden potilastytyväisyys ensihoitopalveluiden laatuun" (in Finnish). The following abstract gives an overview of the outcomes.

Sorsa, E. & Santos, R. (2011). Kanta-Hämeen pelastuslaitoksen Hämeenlinnan ja Forssan toimialueiden potilastyytyväisyys ensihoitopalveluiden laatuun (Patient contentment in the quality of first-aid services in the rescue department of Kanta-Häme in Forssa and Hämeenlinna). Thesis. Theseus. Hyvinkää: Laurea (in Finnish).

Abstract: The purpose of this thesis was to measure the quality of first-aid services from the patients' point of view in the rescue department of Kanta-Häme in Forssa and Hämeenlinna. The study was based on a previous research (Halonen & Pennanen 2009), the purpose of which was to develop an indicator to measure the quality of first-aid services in the rescue department of Kanta-Häme. The aim of this study was to use this indicator to assess the quality of services in the area of Riihimäki. We used the research in question so that all the results would be comparable in all the researches made in the Kanta-Häme rescue department and in the future researches that measure the quality of first-aid services. The questionnaire was sent to patients in Hämeenlinna and Forssa. Of these patients 175 were transferred to extensive care, while 50 of them were treated on the scene. Of the questionnaires 72 (32 %) were returned from both Hämeenlinna and Forssa. The research material was collected in 2011. The research results were entered in the SPSS PASW statistic 18.0- program was used in the analysis of the data. The material was divided into five themes: the general appearance of the ambulance, the professional skills of the ambulance staff, the individuality and uniqueness of the treatment, the patients transferred to extensive care and patients treated on the scene. Open comments could be added in the questionnaire. The study indicated that the most satisfied patients were the ones treated on the scene both in Hämeenlinna and Forssa. The patients were least satisfied with the manner the relatives were taken into account.

The importance of accurate, concise and timely information is very high for the quality of services in medical emergencies. Another research study conducted by nursing students indicates that an electronic paramedic report plays a pivotal role in serving patients in MEVs. Tuomas Telkki worked on a thesis in which he studied the usability of paramedic reports produced by the electronic Merlot Medi system (information system in MEVs). Highly useful results can be achieved by optimizing paramedic reports. The following abstract summarizes his research studies.

Telkki, T. (2012). Ensihoitokertomuksen käytettävyys sairaalan päivystyspoliklinikalla. (Usability of paramedic reports in hospital emergency departments). Thesis. Theseus. Espoo: Laurea (in Finnish).

Abstract: In this thesis usability of paramedic reports produced by electronic Merlot Medi system was studied. The aim of the study was to establish the kinds of paramedic reports that are usable in hospital emergency departments. The information that best benefits treatment of the patients was to be found. Qualitative research was used in the study. The method of the study was theme interview. The results of the interviews were analyzed by qualitative content

analysis. The study was conducted at Jorvi hospital emergency department. 14 nurses working at the department were interviewed. The study results show that electronic paramedic report usability is good. Usability in this thesis is seen as understandability, readability, uniformity and information content that serves well patient care. The usability can be improved by structured outfit, good readability and informational contents. A minimum data set for the reports was identified as development area.

2.4 Significance of ICT Systems and User Needs

Information and communications technology plays a pivotal role in providing emergency services and solutions across Europe. A recent study shows that Finland has one the most cutting-edge emergency services and solutions amongst European countries. The use of ICT systems in ERVs is the main brain behind all operations. Hence, it is the most significant and pivotal elements in collecting user requirements and creating specifications. We have particularly focused our research work on ICT systems and their role in emergency services and solutions. We will now study some students' work and their research studies in this area.

Jani-Heikki Järvinen's research, "Complete Renewing of an Information System. Case: The Finnish Police Force", is part of the reform project of the law enforcement system. This is one of very early research studies in MOBI project. Järvinen carried out his thesis work for the Finnish Police Force. This particular study was conducted from the end-user point of view; suitability analysis of the new user interface was the main objective. Research deals with the compatibility of two CRM systems — Oracle Siebel Investigative Case Management and SAP Investigative Case Management — as the basis of the new system platform for the new law enforcement system. According to the suitability analysis conducted by Järvinen, both systems met the requirements defined for the new system. Oracle's system is generally user-friendly. The unclear workflow and data on time visibility were mentioned as the weaknesses of the system. The Oracle Siebel Investigative Case Management and SAP Investigative Case Management systems are very similar to each other in general. There are no remarkable differences between user interfaces or functionalities. Järvinen presents that some customizing work is needed to improve the usability of the systems. Despite the development proposals, both systems are capable of operating as the platform of the new law enforcement system. The study demonstrated the pivotal importance of ICT systems and user needs. The following is an abstract of the study, which was originally conducted in Finnish.

Järvinen, J.-H. (2010). PATJASTA VITJAAAN; Poliisiasiain tietojärjestelmän kokonaisuudistus. (Complete Renewing of an Information System. Case: The Finnish Police Force). Thesis. Theseus. Espoo: Laurea (in Finnish).

Abstract: This Bachelor's thesis describes a usability research made for the two candidates of which one is to be chosen as the new CRM system when renewing the

complete information system of law enforcement affairs in the Finnish police. The reforming project of the information system is called VTIJA project.

The evaluation explained and clarified, which solutions would suit best to this task in the terms of usability. The evaluation was carried out and based on the screen views of the interfaces. The systems that were evaluated were the CRM systems with law enforcement add-ons of Oracle Finland Ltd and SAP Finland Ltd. Those two companies had by the autumn of 2009 applied for becoming the system provider. The evaluation was made from the point of view of usability and best suitability and is highly respected as an important part of the authorities information system project within the ministry of the interior as the evaluation is made for the possible future solutions of the law enforcement. The expert evaluation was carried out with Oracle Siebel Investigative Case Management (including Oracle Business Intelligence Publisher, a tool for reporting and Siebel Tools for configuration) as well as with SAP Investigative Case Management.

The expert evaluation took advantage of a participating user testing and an applied heuristic evaluation in evaluating the usability, but concentrated more on the user experience gained by the evaluation of the interface. Weaknesses and issues to be improved were discovered more or less equal amount from both systems. Neither system had such serious faults that would most likely to hinder them being chosen and implemented as the new platform for the law enforcement information system. The result of this evaluation supported the outcome and results of the requirement compliance evaluation provided within the VTIJA project and stated that the interfaces of both systems would support most of the requirements set for them. Based on this information the differences on suitability for the intended use for law enforcement purposes are very little. The conclusion, based on the answers and the solutions for the problems in this research is that with the systems evaluated in this study, and the majority of the requirements for information system for VTIJA project can be carried out. External components are, however, needed to complete the system and both software solutions have ready-made integrations for that purpose.

Lauri Iltanen (2012) conducted thesis work commissioned by Duodecim Medical Publications Ltd. The working-life case was focused on using mobile devices in health care services. Studying the following abstract demonstrates that research results were aligned with the primary hypothesis of the importance of ICT systems.

Iltanen, L. (2012). Taulutietokoneet ja älypuhelimet lääkärin työssä. (Use of tablet computers and smartphones in healthcare). Thesis. Theseus. Espoo: Laurea (in Finnish).

Abstract: The objective of this thesis was to research the rate and targets of use of tablet computers and smartphones in healthcare. The researched subjects include applicability of tablet computers and smartphones in healthcare, most prominent manufacturers and operating systems and the future in the use by physicians. The

usage of tablet computers and smartphones in Finland was compared to the usage in the United States of America and Europe. This information was used to determine whether the rate of use in Finland is growing. Characteristics of medical science were considered and based on those it was studied how physicians can benefit from tablet computers and smartphones.

The main information collection methods used in the thesis were written sources, qualitative and quantitative research. These research methods included interviews with healthcare experts and the conduction of two surveys, one for physicians and another for medical students. The surveys examine the use of tablet computers and smartphones. The thesis was commissioned by Duodecim Medical Publications Ltd, a company which has designed and maintained electronic databases used in healthcare for computers and mobile devices for over two decades.

The results of the study indicate that the use of tablet computers, and especially Smartphones is growing at a steady pace. Smartphones are already quite widely used in healthcare, but very few utilize them optimally. Currently tablet computers are used very similarly to smartphones, even though tablet computers have a wider scenario of possible uses. However, it is clear that tablet computers and smartphones can already be more practical in certain uses than desktop computers and laptops.

It is evident after exploring the research work that modern emergency response services and solutions are highly reliant on ICT systems and related technology. The use of technology is increasing day by day, and there is no sign of a stop to this. Our studies demonstrate that it would be highly beneficial to leverage ICT systems to carry out emergency operations. The outcome will give better and more reliable services to customers.

2.5 Extensive Research Work on User-centred Requirements

The MOBI project provided a platform to conduct extensive research work on users' needs and their broad requirements. We have presented a few samples of evidence of our extensive research work in this chapter. Furthermore, it would be helpful to present a summary of a few more works, which will demonstrate the scale of our research study. There are many more conducted research works, reports and theses. However, it is not possible to cover everything in this book. Furthermore, it is also not possible to give a detail introduction to the abstract due to the scope of the book. Let us study a few more abstracts.

Jokitalo, E. & Pohjola, H. (2011). VIRVE -pöytälaitteen käytön osaamisen kehittyminen simulaatio-opetuksen avulla. (Use of VIRVE data terminal network with simulation learning). Thesis. Theseus. Espoo: Laurea (in Finnish).

Abstract: VIRVE, the Authority Radio Network, allows authorities to communicate safely and efficiently with each other over the regulatory limits. VIRVE is a TETRA (Terrestrial trunked radio) standard-based network that offers the opportunity to share a single radio network for several different actors. A simulation learning environment at the Otaniemi unit of Laurea University of Applied Sciences provides an opportunity to practice using VIRVE. The learning environment consists of the trainer's and the trainees' computers, which operate in the network simulation. The purpose of this thesis was to find out how the first year public health nursing students' know-how of the use of the VIRVE data terminal changed after the training simulation. The purpose of this thesis was also to test Kirstinä's and Lehtinen's (2011¹) thesis questionnaire. The main object of this thesis was to enhance nursing use of VIRVE data terminal network with simulation learning. This thesis focused on the first-year public health students. We organized two test events where their awareness of VIRVE was tested using Kirstinä's and Lehtinen's questionnaire. In the test events the students also made a simulation test with the TETRAsim-simulation training program. With the help of simulation tests, we established how quickly the students performed the 15 tasks on VIRVE data terminal network. The students received VIRVE simulation training and used VIRVE data terminal network in SOSTER event.

We compared the results of the first and the second test event. The results were analyzed using Excel computer program. The public health nursing students had not used VIRVE data terminal network before the first test event, thus their VIRVE awareness was low. The students had obtained the basic skills needed to use the VIRVE data terminal and most of them would now have the courage to use it. The knowledge was also reflected in the TETRAsim-simulation test results. In the second test event the test took on average less than half of the time used in the first event. After the training, the students considered the VIRVE data terminal network as a useful tool. On the basis of the results, VIRVE data terminal equipment still appears to have shortcomings, and the students found that its use is not easy. There would still be demand to additional education in the use of the VIRVE data terminal equipment use as more than half on the interviewees felt they needed further training.

Nordling, R. & Pollari, A. (2012). Päivystysalueen Virve-vastaavien näkemyksiä Virven käytöstä. (The opinions on the use of the Virve-network of the personnel responsible for it in emergency room district). Thesis. Theseus. Espoo: Laurea (in Finnish).

Abstract: The planning of the public officials radio network Virve began in the beginning of the 1990's. Its purpose was to enable a safe and efficient radio network for public officials, consequently replacing the formerly used communication systems. The network was finished and inaugurated in the beginning of the millennium. The main users of the Virve-network are rescue and police patrols, border protection services, customs, the armed forces, social services,

and health care personnel. In the last few years, private members have also joined the network.

The purpose of our study was to find out about the views those responsible for the use the Virve-network at emergency rooms have on the use of the system. The goal was to develop the training of the use of the network both for currently practicing hospital staff and graduating students.

The target groups of the conducted interviews were the emergency room personnel that were in charge of the Virve-network at Jorvi, Lohja, and Tammissaari hospitals. The staff in each of the hospitals was qualified health care personnel, and its experience in the field ranged from one and a half years to ten years.

Their experience with the Virve-network varied from a few months to a few years. The study was executed as a qualitative study. Theme interviews were used to gather the data. Those in charge of the Virve-network at Jorvi, Lohja, and Tammissaari emergency rooms participated in these interviews. The interviews were themed as follows: to what extent is the Virve-phone used within the emergency room is districts, for what purposes is the phone used, and have those in charge of the Virve-network received sufficient training in order to be able to educate other health care personnel in its use.

The interviews were recorded and analysed with content analysis methods. The findings show that the quality of the basic education received on the use of the Virve-phone varies, and the use of the system remains minimal. The interviews revealed that information and forewarning from the incoming emergency vehicles are mainly communicated via mobile phone. The Virve-phone is not used for internal communication between the emergency room and the hospital wards. Practices and drills between HUS- hospitals and their administration have been the only occasions when the Virve-phone has been used for its proper purposes. Everyone interviewed communicated a pressing need for the improvement of training for the use of the Virve-network.

Based on these findings, Virve training should be more oriented towards practical applications of the network. This might in turn facilitate and spread its use within emergency room districts. Our study may be used when planning supplementary Virve training for both students and practicing health care personnel.

2.6 Conclusion

The changing nature of technology and related components are demanding rapid changes in operational methods of emergency rescue vehicles (ERVs). The MOBI project's Work Package 2 emphasises user needs in current and future situations. The scope of user needs is very broad and needs to funnel down to an important area. Our research has identified eight areas of focus. The research evidence provided here presents scientific facts, findings and

recommendations to standardize ERV processes and solutions. We highly recommend our research findings be considered while building next generation ERVs. The implementation of scientific findings will improve emergency services and solutions across the spectrum.

References

Iltanen, L. (2012). Taulutietokoneet ja älypuhelimet lääkärin työssä. (Use of tablet computers and smartphones in healthcare) Thesis. Theseus. Espoo: Laurea (in Finnish).

Jokitalo, E. & Pohjola, H. (2011). VIRVE -päätelaitteen käytön osaamisen kehittyminen simulaatio-opetuksen avulla. (Use of VIRVE data terminal network with simulation learning) Thesis. Theseus. Espoo: Laurea (in Finnish).

Järvinen, J-H. (2010). PATJASTA VITJAAN; Poliisiasian tietojärjestelmän kokonaisuudistus. (Complete Renewing of an Information System. Case: The Finnish Police Force) Thesis. Theseus. Espoo: Laurea (in Finnish).

Lyytikä, E. (2012). Lainsäädännön vaikutus lokienhallinta-järjestelmän vaatimusmäärittelyyn: tapaustutkimus julkisesta terveydenhuollosta. (The legislation impact on the requirement specifications for the log management systems design: Case study on the public health care sector) Thesis. Theseus. Espoo: Laurea (in Finnish).

Nordling, R. & Pollari, A. (2012). Päivystysalueen Virve-vastaavien näkemyksiä Virven käytöstä. (The opinions on the use of the Virve-network of the personnel responsible for it in emergency room district) Thesis. Theseus. Espoo: Laurea (in Finnish).

Rathod, P. & Kämppe, P. (2013). in Proceedings of the 2nd IEEE International Conference on Connected Vehicles & Expo (ICCVE 2013), December 2-6, Las Vegas, Nevada, USA.

Roisko, V. (2014). Usability evaluation of TETRA mobile radio in Public Protection and Disaster Relief (PPDR) vehicles. Master Thesis. Espoo: Aalto University (In Press).

Sorsa, E. & Santos, R. (2011). Kanta-Hämeen pelastuslaitoksen Hämeenlinnan ja Forssan toimialueiden potilastytytyäisyys ensihoitopalveluiden laatuun (Patient contentment in the quality of first-aid services in the rescue department of Kanta-Häme in Forssa and Hämeenlinna) Thesis. Theseus. Hyvinkää: Laurea (in Finnish).

Telkki, T. (2012). Ensihoitokertomuksen käytettävyys sairaalan päivystyspoliklinikalla. (Usability of paramedic reports in hospital emergency departments) Thesis. Theseus. Espoo: Laurea (in Finnish).

Urpila, T. (2012). Sopimuspalokuntien pelastusajoneuvojen sähkötekniset laitteet ja järjestelmät. (Electrical device and information technology in firefighting vehicles of volunteer fire departments) Thesis. Theseus. Espoo: Laurea (in Finnish).

3 Vehicle Infrastructure

Pasi Kämppi, Jyri Rajamäki & Ilkka Tikanmäki

A modern emergency vehicle is a complicated combination of technology, and it has to survive in different conditions depending on usage. It has to be reliable and flexible, and it has to be able to carry people and equipment. An emergency vehicle also has to provide electricity for an increasing number of electronic devices. One target of the MOBI project was to describe how a standard commercial vehicle is used as a platform and transformed into a field-proven tool for security and rescue professionals. Another target was to provide improvements for existing problems, such as electricity consumption. This chapter describes emergency vehicle infrastructure design principles for commercial vehicle platforms, retrofits made by the MOBI project, and how emergency vehicle preparedness could be improved.

3.1 Introduction

Dr. Jyri Rajamäki presents in his article a layered design model for emergency vehicle ICT system integration that is based on a commercial vehicle platform (Rajamäki, 2013). Rajamäki suggests that the emergency vehicle ICT-system integration could be divided into four layers: an actor-specific services layer, a service platform and common services layer, a communications layer, and a vehicle infrastructure and power management layer. In this model, the vehicle infrastructure and power management layer will provide the wheels, space and electricity for the ICT systems.

3.2 Vehicle Platform Based Features

The MOBI project concentrated on van-sized emergency vehicles, and research was based on an analysis of Finnish ambulances and van-sized police patrol and rescue vehicles. Finnish van-sized emergency vehicles are based on commercial vehicles (e.g. Volkswagen Transporter, Mercedes Benz Vito, Ford Transit and Chevy Van) that are modified to be emergency vehicles by implementing several retrofits for the vehicle platform by a third party. The emphasis of the research work was on the van-sized police patrol vehicle (Volkswagen Transporter).

Although a modern emergency vehicle contains several retrofits, many features still originate from the vehicle manufacturer. The engine, transmission and four-wheel drive

come from the car manufacturer, but the engine performance and the type of the gearbox is determined by the vehicle owner. In some cases, a more powerful alternator is installed to provide more battery charging capacity. Moreover, vehicle body related features such as wheels, steering and suspension are identical to the commercial model, but they can be improved if needed. A modern vehicle platform also contains important safety and driver-assistance features like airbags, ABS (Anti-lock Braking System), ESP (Electronic Stability Control) and EDL (Electronic Differential Lock) that could help the driver in demanding conditions, e.g. in winter. An embedded computer and car supervision system is not allowed to be modified but a CAN (Controller Area Network) interface can provide information for a separate onboard computer.

3.3 Retrofits for Vehicle Platform

As discussed in the previous chapter, the MOBI project concentrates on modelling how a modern emergency vehicle is modified from a commercial van to an emergency vehicle. The most important thing is to define the purpose of the vehicle and make decisions how the space is divided as effectively as possible. In his article, Rajamäki (2013a) presents that the vehicle could be divided into two or three sections, depending on the vehicle's purpose, e.g. cabin and patient space, or cabin, mobile office and transport unit. See Figure 3. The purpose of the vehicle also defines what kind of equipment is needed in the field. A mobile office needs benches and a table, while a patient space is filled with treatment equipment.

A modern emergency vehicle is equipped with effective alarm lights and a complicated ICT system with many wires and antennas. This challenging paradigm is solved in an innovative way by implementing a modular retrofit process. The original roof of the vehicle is cut off, and a new plastic roof with integrated alarm lights is fitted in. This procedure also increases the interior height, provides space for antennas and wires and speeds up the retrofitting process. The interior is built according to the need. The same vehicle platform can be modified to have space for a police patrol dog or a large variety of investigation equipment.

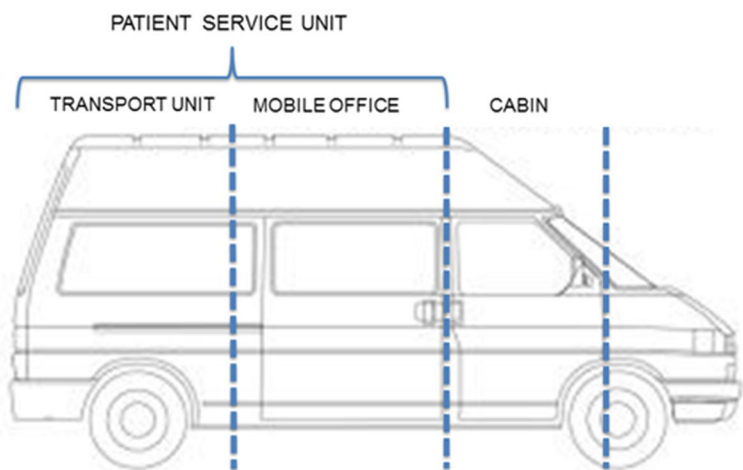


Figure 3 Emergency vehicle’s segmentation for sections.

Due to the large number of electronic devices, an emergency vehicle requires a lot of battery power. According to Rajamäki (2013a), emergency vehicles are equipped with additional batteries, an intelligent power supervision system, and the possibility to charge batteries from an external source. There is also an inverter to provide 230 V for additional equipment such as printers and laptops.

As a practical example, Rantama (2011) presents in his study what vehicle platforms are used to build rescue vehicles and how they are equipped.

3.4 Retrofits Made in the MOBI Project

The increased amount of electronic equipment carried (such as onboard computers, LCD displays, multichannel routers, speed radars and treatment equipment) has also dramatically increased battery consumption. The current design principle includes additional batteries, but the battery technologies used have certain limitations in storing enough energy in batteries. Laurea started a research process with Akkuvoima Oy to find out what kind of battery technologies are currently available and which of these are suitable for emergency vehicles. The target was to build a proof of concept into the real vehicle platform with the latest fitted battery technology available.

As a result of a research process, the current lead-acid batteries were replaced with modern NiMH (Nickel Metal Hydride) batteries manufactured by SAFT. The new battery pack provided 28% more capacity with same volume compared to the original battery, and it should have at least a lifetime of ten years. Additionally, the new battery pack has integrated electronics for battery-cell self-supervision and a communication interface for external applications (e.g. real-time cell supervision). ON the negative side, the new battery system cannot be charged with an existing charger/inverter. The problem was solved by using an additional power source dedicated to the new battery system.

The students in the Metropolia University of Applied Sciences' Automotive and Transport Engineering Degree Programme joined the MOBI project at the end of 2012. The target of the project team (Juuso Salo, Pasi Ravantti, Jukka-Pekka Soinila, Henri Vares, Heikki Hyvämäki and Miika Puolitaival) was to plan and implement an application for the new battery system with real-time supervision and data-logging capability. As a result of the research process, the project team delivered an application that could monitor battery voltage (V), current (A), charging state (%) and temperature (C) in real time. The application was installed in a vehicle's onboard computer. The project team also proposed a few options as alternative energy generation methods. Detailed information is available in the study report.

Salo, J., Ravantti, P., Soinila, J-P., Vares, H., Hyvämäki, H. & Puolitaival, M. (2013). Poliisiauton virransyöttöjärjestelmän päivittäminen (Battery system upgrade for police vehicle). Report. Helsinki: Metropolia University of Applied Sciences.

Field tests showed that the new battery system works very well in the police vehicle (VW Transporter T5). All battery cells are charged properly by the vehicle alternator; real-time monitoring application works very smoothly and the data-logging capability provides data for analyzing battery usage. The results of the field study are presented in the study, “Smart Battery System for Emergency Vehicles: Results from a Pilot Field Study” by Kämppi and Rathod.

Kämppi, P. & Rathod, P. (2013). Smart Battery System for Emergency Vehicles: Results from a Pilot Field Study. 2nd International Conference on Connected Vehicles & Expo. Las Vegas, Nevada, U.S.A. (In print).

Abstract: Current emergency response vehicle (ERV) is exceedingly complicated combination of different technologies and solutions to function and perform in varying conditions. The challenge starts as there are no common agreements for how ERV's should be designed to meet requirements of all actors involved in emergency services. In Finland, Laurea University of Applied Sciences has launched a project that concentrated on emergency vehicles. The target of the project was to create user requirements for designing emergency vehicles, also to describe used ICT-systems, investigate power consumption and create a demo vehicle with new innovations. Due to wide range of the electric and electronic equipment, the power consumption of modern emergency vehicle is very high. During user requirements phase users indicated strongly that battery is draining out fast and vehicle personnel have very limited possibilities to check actual battery health state. To fulfill actual user need we launched a research study that focused on finding out 1) a solution to improve battery capacity with longer battery lifetime, 2) to improve personnel awareness about battery health state and 3) to implement a proof-of-concept in real emergency vehicle. This paper is reporting those findings of the experiment and pilot field study.

3.5 ERV Field Operation Preparedness

Emergency vehicles have to be ready for service on a 24/7 basis. Preventive maintenance has a vital role in guaranteeing emergency vehicle operation preparedness, but maintenance procedures during and after a working shift are important, too. The thesis work of Virve Häyriinen covers what maintenance processes are integrated into daily routines in the police and rescue organizations. The main focus of the thesis was to describe current maintenance processes in the field. During her study, Häyriinen conducted 19 interviews among security professionals from police and rescue organizations.

Häyriinen, V. (2013). Hälytysajoneuvojen päivittäiskäyttöprosessit. (Daily operating processes for emergency vehicles). Thesis. Theseus. Espoo: Laurea (in Finnish).

Abstract: In autumn 2010 Laurea University of Applied Sciences started a three-year development project for the MOBI (Mobile Object Bus Interaction) official car

together with its cooperation partners. The purpose of the project is to lay grounds for an official and emergency vehicle concept aiming at exports. MOBI aims at commencing a standardization development together with countries and organizations that think alike.

This thesis focuses on the daily use of emergency vehicles. With the help of material gained from the investigation work, process descriptions of the different functions related to the daily use of the vehicle were formed. Research data that helps MOBI in determining the user needs of emergency vehicles and in testing the demo vehicle of the end product of the MOBI project was gained by this means.

The data for the functional thesis was mainly gathered in field circumstances by observing the work of policemen, fire masters and ambulance drivers during their work shifts. The research was carried out in the region and units of Western Uusimaa's police and rescue stations. With the help of observation and interviews, information was obtained on how and in what kind of circumstances the emergency vehicles operate. Three different research methods were applied in the research; interviews, observation and various literary sources, such as checklists that organizations have compiled for the purpose of checking the condition of the vehicles and their usage.

On the basis of the material gained in the research, process flow charts on the different processes of the work shift were formulated, such as the initial inspection of the vehicle before starting the work shift. The description of processes document by the Advisory Committee on Information Management in Public Administration, JUHTA, was utilized in describing the processes.

The research work of the thesis focused mainly on exploring the present state, but it nevertheless also produced development suggestions from the perspective of the end users of the vehicle. These development suggestions provided valuable information for the MOBI project and ended up being used in the project. These development suggestions will not be presented in this thesis, however

Another research team (Jyri Helenius, Elisa Kurki-Suonio and Ari Salonen) from the Metropolia Automotive and Transport Engineering Degree Programme also joined the MOBI project at the end of 2012. Their task was to define the technical solution for the automatic vehicle health check routine, e.g. an integrated onboard computer. After the research work team figured out that the vehicle-embedded supervision system is able to detect all vital problems and an additional supervision system is not needed. The embedded supervision system can supervise the engine, brakes, bulbs, doors and battery. An extensive list of supervised objects can be found in the detailed report.

Helenius, J., Kurki-Suonio, E. & Salonen, A. (2013). Health Check for Police Car. Report. Helsinki: Metropolia University of Applied Sciences.

This project was a part of bigger project, which goal was to compose a new health state monitoring system for police vehicles. The project was made in co-operation with Laurea University of Applied Sciences. Main goal in this project was to find out what information police officers need about their vehicle health state during a shift. It was found that there is no need to build new system for vehicle health state monitoring and the embedded vehicle health status monitoring system is able to deliver all needed information for the police officers.

A modern emergency vehicle carries a lot of equipment, and it is extremely important to be sure that all needed tools are available in field operations. Master's student Timo Timonen and the research team of Bachelor students (Veikko Rahikainen, Christian Wasastjerna and Markus Salonvaara) investigated if Radio Frequency Identification (RFID) technology could be used as an inventory system. Timonen and the research team worked independently, but the results are the same: RFID technology could be applied in emergency vehicles. The research work covered field testing in a real police vehicle with a handheld RFID reader and different types of RFID tags. Timonen continued his studies with Dr Rajamäki, and they presented their results at the 2nd International Conference on Information Technology and Computer Networks, October 2013. Detailed results can be found from Timonen's Master's thesis, the research team's research report and from the study of Timonen & Rajamäki (2013).

Timonen, T. (2013). RFID-teknologian hyödyntäminen poliisin toimintavarmuuden varmistamiseksi: Case poliisipartio. (The utilization of RFID-technology in law enforcement: Case Police patrol). Master thesis. Theseus. Espoo: Laurea (in Finnish).

Abstract: The research question of this study was the following: How can RFID technology be utilized in law enforcement operations?

The objective of this study was to examine the suitability of RFID technology in law enforcement operations, such as the locating, detecting and identifying of equipment. The police departments have numerous vehicles and pieces of equipment that at the moment are identified and tracked manually. The demand for this study has arisen from an earlier need charting undertaken as part of Laurea's Mobi project.

The study was conducted as a case study (Case Study Research Analysis). This research method was chosen as a case study aims to collect a comprehensive data set of source material and to further describe the subject matter in depth.

The study concludes that RFID technology is a completely viable option in law enforcement operations. The conducted field tests resulted in a positive outcome and the benefits of RFID technology in this application are indisputable. The study revealed that the subject organisations need to provide employees with a faster way to complete an inventory of patrol car equipment, by utilizing RFID technology tools

and applications. The work of the most important results are summarized in a scientific article that was posted in the endorsement international conference.

Rahikainen, V., Wasastjerna, C. & Salonvaara, M. (2013). *RFID-tekniikan soveltaminen poliisiautossa (Applying RFID-technology in the police vehicle). Report. Espoo: Laurea (in Finnish).*

This study presents the results of field-testing for RFID-based equipment identification system in van sized police patrol vehicle. Test were executed with handheld RFID-reader, six different types of soft RFID-tags and six different types of hard RFID-tags. There was found that the results depend strongly on used RFID-tag type, surface and the tag placing in the vehicle. As a summary, this study shows the importance of field-testing in system verification process.

Timonen, T. & Rajamäki, J. (2013) "RFID Technology as an Inventory Tool for Future Emergency Service Vehicles", in *Recent Advances in Computer Engineering Series*, vol. 16: *Proceedings of the 2nd International Conference on Information Technology and Computer Networks (ITCN '13)* edited by Sergio Lopes, pp. 142-145, WSEAS Press.

Abstract: - A modern emergency service vehicle carries a lot of equipment, for example Finnish Police cars are equipped with an average of about 100 different types of equipment. It is extremely important to be sure that all needed tools are available in field operations. The objective of this research paper is to examine the suitability of RFID technology in law enforcement field operations, such as the locating, detecting and identifying of equipment in the emergency vehicles. The police departments have numerous vehicles and pieces of equipment that at the moment are identified and tracked manually. According to our field tests within a real police car, RFID technology's biggest benefits are improved work quality and time saving. The results show that the remote identification, enable the police to make a car equipped with an inventory of up to three times faster than by hand.

3.6 Conclusion

This chapter described how commercial van-sized vehicles are transformed into field-proven tools for security professionals. The main issues are to define the purpose of the emergency vehicle, select the right vehicle platform with the needed features and define the needed retrofits. Emergency vehicle preparedness can be improved by technological solutions, but daily routines are important, too.

Anyhow, a current trend is that emergency vehicles are used more and more like mobile offices and the number of tools carried increases day by day. This trend creates extremely high demands for energy storage and generation. The MOBI project proposes a solution to

improve energy storage capacity in emergency vehicles, but alternative energy generation methods need to be studied more deeply in future projects. Also, tools for automated equipment inventories are developed and tested.

References

Helenius, J., Kurki-Suonio, E. & Salonen, A. (2013). Health Check for Police Car. Report. Helsinki: Metropolia.

Häyrynen, V. (2013). Hälytysajoneuvojen päivittäiskäyttöprosessit. (Daily operating processes for emergency vehicles) Thesis. Theseus. Espoo: Laurea (in Finnish).

Kämppi, P. & Rathod, P. (2013). Smart Battery System for Emergency Vehicles: Results from a Pilot Field Study. 2nd International Conference on Connected Vehicles & Expo. Las Vegas, Nevada, U.S.A. (In print).

Rahikainen, V., Wasastjerna, C. & Salonvaara, M. (2013). RFID-tekniikan soveltaminen poliisiautossa (Applying RFID-technology in the police vehicle). Report. Espoo: Laurea (in Finnish).

Rajamäki, J. (2013). The MOBI Project: Designing the Future Emergency Service Vehicle. IEEE Vehicular Technology Magazine, vol.8, no.2, June 2013, 92-99.

Rantama, M. (2011). Pelastusajoneuvojen tekninen selvitys. (Technical report about emergency vehicles). Report. Kuopio: Emergency Service College (in Finnish).

Salo, J., Ravantti, P., Soinila, J-P., Vares, H., Hyvämäki, H. & Puolitaival, M. (2013). Poliisiauton virransyöttöjärjestelmän päivittäminen (Battery system upgrade for police vehicle). Report. Helsinki: Metropolia.

Timonen, T. (2013). RFID-tekniikan hyödyntäminen poliisin toimintavarmuuden varmistamiseksi: Case poliisipartio. (The utilization of RFID-technology in law enforcement: Case Police patrol). Master thesis. Theseus. Espoo: Laurea (in Finnish).

Timonen, T. & Rajamäki, J. (2013) "RFID Technology as an Inventory Tool for Future Emergency Service Vehicles", in Recent Advances in Computer Engineering Series, vol. 16: Proceedings of the 2nd International Conference on Information Technology and Computer Networks (ITCN '13) edited by Sergio Lopes, pp. 142-145, WSEAS Press.

4 Communications

Jyri Rajamäki, Piia Kallio, Ella Pelkonen, Ilse Tuohimaa & Salla-Mari Kalasniemi

In general, ERV communication systems are not standardized and the interoperability between PPDR actors is still inadequate. This chapter concentrates on long-distance communications, and the aim is to create an internationally functional platform for PPDR actors to communicate. The structure consists of five sections: After the introduction, the multi-organizational communications environment of ERVs is discussed. Section 4.3 presents some special needs that law enforcement authorities have for their communications systems. Section 4.4 concentrates on the Distributed Systems Intercommunication Protocol (DSiP). Finally, some aspects of the Finnish VIRVE Network are covered.

4.1 Introduction

ERV communications needs can be divided into long-distance communications, local area networks and accessory communications. Furthermore, each category is scaled from light to heavy. ICT solutions have to be robust and easy to install. Special attention has to be paid to information security. Various encryption methods between different kinds of systems bring their own challenges to this project and its information security solutions. In addition, each PPDR actor has their own requirements on how to implement information security in their vehicles' systems.

The MOBI demo vehicle was equipped with a TETRA radio mainly used for voice communications and a separate multichannel router, which was connected to the control and command room applications via parallel TETRA, 2G/3G, LTE/4G, WLAN and satellite data access technologies. A multichannel router offered a redundant solution when more than one functional data communication channel for data transmission exists. Figure 4 shows the communications system of the MOBI demo vehicle. The Distributed Systems intercommunication Protocol (DSiP) allowed the use of several parallel communication paths simultaneously. DSiP handled communication channel selection and hid link establishment issues from devices and/or software that wished to communicate with each other using the DSiP solution. The Multichannel Router's Quality of Service (QoS) option set the desired order of the network access by the desired Cost of Service (CoS) value. Therefore, when operating in areas where the network availability and signal strength vary widely, the

network exchange should proceed without the user noticing it and without breaking the connection. The user organization will choose in advance whether to use either the strongest signal or the cheapest cost network, or some combination of these rules. This selection was done by setting the value of the CoS.

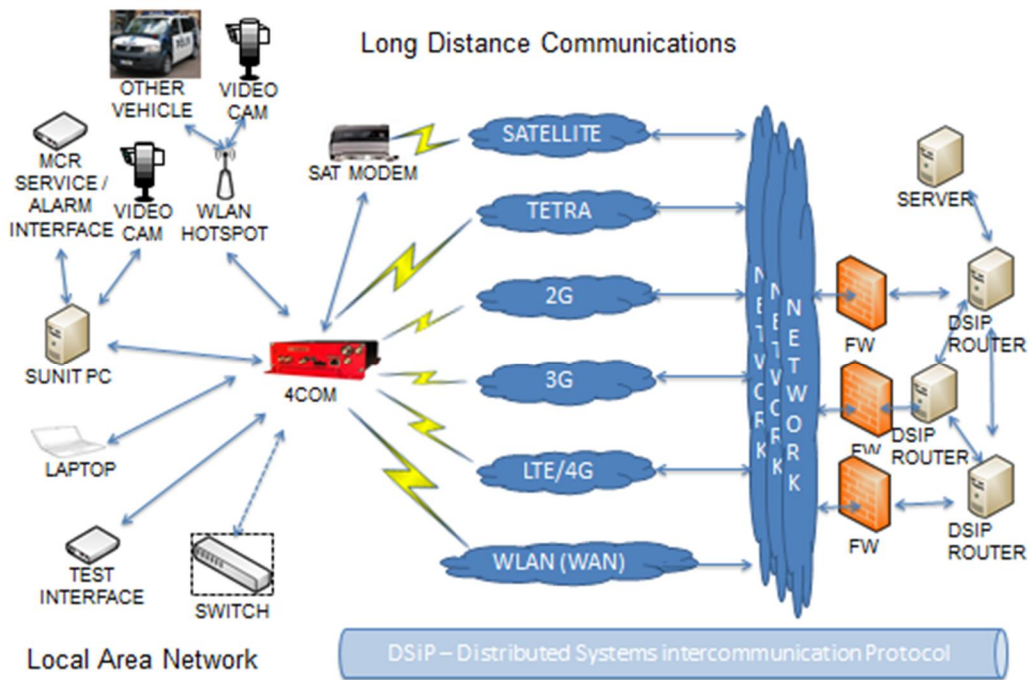


Figure 4 MOBI demo vehicle’s communications system. (Kämppi & Tikanmäki, 2013)

There is a need for secure, uninterruptible communication in many applications. Different approaches have been addressed to mitigate the problems; examples include Multi-Path TCP-stack (MPTCP) and an open source project with a multichannel VPN solution (OpenVPN). However, DSiP appears to be the only commercially available solution today that addresses a large scale of known problems. When comparing Communications Access for Land Mobiles (CALM) for intelligent transportation systems initiative by the ISO to DSiP, CALM is still a work in progress. Therefore, large-scale implementations of the standard do not yet exist. Instead, DSiP-based systems have been in operative use in critical installations for several years, e.g. the Finnish Coast Guard’s coastal surveillance solution and SCADA control of Finland’s main power grid. Another reason for selecting the DSiP solution for our demo vehicle is that the CALM architecture is based on an IPv6 convergence layer that decouples applications from the communication infrastructure, whereas, DSiP is insensitive towards the transport layer and it may freely use IPv4 and IPv6 networks as transport with tunnelling capabilities. Also, compared to CALM, applications may use and transparently communicate through the DSiP mesh without having to implement the interfaces with APIs. This effectively means that there is no need to modify applications or equipment when applying the DSiP.

4.2 DSiP-Based Data Communications

Ahokas, Rajamäki & Tikanmäki (2012) have studied cyber-secure public safety communication systems. Their study presents a new highly redundant and secure data communications network solution for PCS. The solution is based on the Distributed Systems intercommunication Protocol (DSiP), which offers all PPDR actors their required features. When different offices are using their own communication solutions, such as a TETRA network and IP-based networks, DSiP is seen as a solution to combine these network systems.

Ahokas, J., Rajamäki, J. & Tikanmäki, I. (2012). Secure and Redundant Public Safety Communication Network for Public Protection and Disaster Relief (PPDR) Organizations. *International Journal of Communications*, Issue 3, Volume 6, 2012, pp. 120-127.

Abstract: European Public Protection and Disaster Relief (PPDR) organizations have similar needs for communications. A common network for PPDR creates synergy and makes interoperability possible. This paper presents a new highly redundant and secure data communications network solution for Public Safety Communications (PCS). The solution is decentralized and communications paths are redundant. Even if the network layer is shared with different users or different use purposes all communications remains secured and access controlled. Distributed Systems intercommunication Protocol (DSiP) offers all of these features in a single solution. This enables building cyber-secure data network for PPDR organizations. Even though the communications channels are reliable and secured, there are still some issues to be considered. This paper introduces these issues and offers solutions for these challenges.

Holmström, Rajamäki and Hult (2011) have explained further functions of DSiP in their article DSiP Distributed Systems intercommunication Protocol — A Traffic Engineering Solution for Secure Multichannel Communication. DSiP is able to use multiple parallel telecommunication connections and combine them.

Holmström, J., Rajamäki, J. & Hult, T. (2011). DSIP Distributed Systems intercommunication Protocol - A Traffic Engineering Solution for Secure Multichannel Communication, 10th WSEAS International Conference on Applications of Computer Engineering, March 24-26, 2011, Playa Meloneras, Gran Canaria, Canary Islands.

Abstract: The importance of reliable telecommunication is constantly increasing. The DSiP-solution makes it possible to distribute all telecommunication among several operators and methods, resulting in a true multichannel communication system. The DSiP-multichannel routing solution increases reliability, security and integrity in telecommunication and allows regular communication methods to be used in mission critical telemetry systems. This is achieved by splitting risks

between operators and communication channels; better routing capabilities; taking security and intrusion risks into account; and adding modularity.

Ehsanul Ukil (2013) created a concept for verifying a multichannel data communications concept for emergency vehicles. He also made some preliminary field tests.

Ukil, E. (2013). *Field testing for verifying a multichannel data communication concept for emergency vehicles*. Thesis. Espoo: Laurea.

Abstract: This thesis examines a multichannel data communication concept that has been developed for secure, reliable and strong communication between emergency vehicles. The goal of this thesis is to verify the experimental performance of this concept. In order to test the performance, four testing parameters, which are bandwidth, jitter, packet loss and latency, were chosen. These parameters were tested by two network performance measurement tools which are named IPERF and speedtest. At the end of this thesis, the test results are presented, and a shallow analysis is given. In the appendix, details of the field testing report are attached. This will help experts to conduct in-depth analysis of the performance of the multichannel data communication concept. During field testing, some expected and unexpected interruptions occurred due to work with a newly conceptualized scheme. Ultimately, all planned milestones were achieved. By field testing, several communication networks for emergency vehicles have been successfully used. In case of failure of one or more communication networks, there is still a possibility to connect using other available options. Working with this thesis project, I have learnt the conceptual overviews and experimental procedures of the testing of data communications technologies. Learning by developing (LBD) is exemplified in this work.

As part of the MOBI project, more user-friendly interfaces of network controls were studied and developed using Java. The thesis work of Vilpas (2012) investigates how the Java programming language is applied to manage DSiP multichannel routing system configuration files. Bertling (2011) created in his thesis a program to help visualize the number of connections in DSiP. Near to Bertling's subject, with the same idea of creating a program to visualize data, Alaverronen (2012) presented in his thesis a computer program that shows the amount of data traffic in DSiP. Both Bertling and Alaverronen used Java as their programming language in their studies because Java is widely used as a programming language and is not connected to specific platforms. It is reasonable to question assumptions of Java's suitability in these kinds of programs. Vilpas compared Java's functions and flaws with some similar programming languages and built a graphical management interface to investigate the suitability. The benefits of the Java programming language is its scalability for different operating systems and exception processing. According to Vilpas, there are several imperfections in Java. For example, there is no meta-programming feature available. Features of Java in general are simple but different compared to other programming languages like C# and Scala. Mr. Vilpas also explored the suitability of the software platform for his pilot studies. Normally, it is advised that the suitability of a development platform must be reviewed and match with the particular PPDR

service provider's requirements. In the thesis, Vilpas concentrates on functions of the configuration editor, while Bertling and Alaverronen were creating a program to display the number of connections and the amount of data traffic. Therefore, the theses and their results cannot have been fully compared, but their subjects are very close to each other.

Vilpas, M. (2012). Javan soveltuvuus DSiP-reititysjärjestelmän asetusmuokkaimen luontiin (The suitability of Java in the creation of a DSiP routing system configuration editor). Thesis. Theseus. Espoo: Laurea (in Finnish).

Abstract: The purpose of this thesis' research is to discover how well the Java programming language is applied to building a typical graphical user interface program. Since Java is a widely used programming language in the software business, many organizations may choose it as their primary programming language solely for this reason. If there were to a language more effective than Java and suitable for a particular organization, it would gain a competitive advantage over its competitors.

The study was conducted by building a graphical user interface program that manages configuration files for a DSiP (Distributed Systems Intercommunication Protocol) multichannel routing system. In addition to building the program, the pros and cons of the language observed during program development were compared to other programming languages.

The comparison took multiple programming paradigms and execution environments into account. The research showed that Java is a good but limited programming language. It provides a solid set of basic programming tools, but its development, at times, is stiff and laborious. More versatile languages than Java are available to the programmers today, and some of these languages even apply to the same paradigm and execution environment as Java.

Bertlings and Alaverronens thesis subjects are basically the same, thought programs that were created were different. Alaverronen notes that there are possible ways to develop his program forward when Bertling describes in thesis more finished program. Both program achievements are passed onto the organization who ordered them but yet whether they are going to publish them is unknown.

Bertling, M. (2011). Kytcentöjen määrän visualisoiminen Javalla DSiP-lokitiedostoista (Visualization of connection counts from DSiP log files with Java). Thesis. Theseus. Espoo: Laurea (in Finnish).

Abstract: Ajeco Oy has developed a DSiP (Distributed Systems intercommunication Protocol) multichannel solution to provide reliable networking for critical applications such as law enforcement. They needed a system independent tool to

help them analyze the state of the network on a short and long term scale. The objective was to code a program that would accomplish this through analysing the DSiP log files. Java was chosen as the coding language since it is a system independent language.

Within the given constraints software architecture was drawn up and based on that the program was developed. During the development process it became apparent that an overarching view was needed as well. Thus the program was further developed based on this feedback and an overview tab was added to it. This enables the program to provide the big picture of the entire network at one glance.

The project achieves the objectives set for it. The code and graphical user interface are up to expectations. The project was executed independently and development proposals were taken in to account. "Based on the log files, the program draws an understandable graph that helps the user to see how often the node has connected and disconnected. From our point of view the project has been completed commendably." (Holmström 2011.) This project demonstrated that Java is a good choice for developing a platform independent program that extends the standard graphical user interface.

Alaverronen, S. (2012). Liikennemäärien visualisointi Javalla DSiP-lokitiedostoista (Visualization of data traffic amounts from DSiP log files with Java). Thesis. Theseus. Espoo: Laurea (in Finnish).

Abstract: DSiP, Distributed Systems intercommunication Protocol, is a system created by Ajeco Oy that aims to guarantee a reliable data transfer and security on the network. This is achieved by routing communications via multiple channels, using many different communication mediums. The system produces log files that can be used to follow the behaviour of nodes on the DSiP network. The data in these log files are not very easily readable, so another way had to be created to interpret the data.

The purpose of the thesis is to create a program that reads the log files created by the DSiP system and modifies the data traffic amounts in those log files to more easily understandable visual form. Also the program is required to support multiple languages and adding a new language does not require any code changes to the program itself. The program should also be executable on multiple platforms.

The program is written in the Java programming language in the Netbeans integrated development environment. With the help of this program, the user can choose the required log file, and define the start time as well as the timeframe. With these values, the program can read from the log file the values and draw them as a column graph. The program will also write the data to a separate tab. Both the column graph and the written text are colour coded with three different colours, red, yellow and green. The border values of these colours can also be

changed in the configuration menu. Changing the language is simple and does not require any code changes to the program.

The program has achieved all the functional requirements set for it and its source code has been handed over to the customer. It is still unclear if the company will start using the product, or if they will refine it even further.

4.3 Multi-Organizational Data Communications with DSiP

Rajamäki (2012) has studied cyber-secure Public Safety Communication (PSC) systems. His study presents a new highly redundant and secure data communications network solution for public safety, military and critical infrastructure protection. The solution is based on the Distributed Systems Intercommunication Protocol (DSiP), which offers all actors their required features.

Rajamäki, J. (2012). Decentralized cyber secure public safety communications and information management systems for a multi organizational environment. Plenary Lecture 2. The 3rd International Conference on Energy, Environment, Devices, Systems, Communications, Computers (INEEE'12), Rovaniemi, Finland, April 18-20.

Abstract: The military (MIL), public protection and disaster relief (PPDR) as well as critical infrastructure protection (CIP) actors have multiple similar needs. Similarities in disaster relief mission scenarios include 1) serious disruptions in expected functionalities of critical infrastructures, e.g. transport, supplies, infrastructures, 2) operations in remote areas without communication infrastructures, 3) cross border/ multinational teams, 4) high request for interoperability, 5) no remaining infrastructures after a serious disaster, 6) congestion or no use of commercial networks, and 7) utilizing both AdHoc networks and permanent infrastructures. Similarities in command and control communications involve 1) need to receive information on the operational environment, 2) need for the decision maker to watch operation (live feed), 3) need to decide and emanate orders, and 4) need to assess the evolution of the operational situation after decision. A common cyber secure voice and data network for MIL, PPDR and CIP brings synergy and enables interoperability; separate networks are wasting of resources. This lecture focuses on future broadband data communication needs of MIL, PPDR and CIP actors and presents a new cyber secure data communications network structure for a multi organizational environment. The architecture is fully decentralized and all critical communication paths have redundancy. Although having common physical connections, all network actors and elements (multichannel routers, nodes) are identified as well as every organisation's all user levels and their rights to different data sources are known. The decentralized architecture based on the Distributed Systems intercommunication Protocol – DSiP is highly fault-tolerant in normal

conditions as well as in crises. The software-based approach is independent from different data transmission technologies, from IP core networks as well as from services of telecommunication operators. The solution enables to build a practical and timeless cyber secure data network for multi organizational environment, which being fully decentralized is hard to injure. The networks of different organizations are virtually fully separated, but if wanted they can exchange messages and other information which makes them interoperable.

Rajamäki, Holmström & Knuuttila (2010) present a common international ICT infrastructure for all emergency vehicles. The DSiP protocol has been tested for this usage. Working in the field, the vehicle is the most important tool you have. There are so many different devices in the car that there is no extra space for new systems. Therefore, it would be easier if most ICT systems were integrated or virtualized and working together.

Rajamäki, J., Holmström, J. & Knuuttila, J.(2010). Robust Mobile Multichannel Data Communication for Rescue and Law Enforcement Authorities. 17th IEEE Symposium on Communications and Vehicular Technology in the Benelux, November 24-25, 2010, University of Twente, The Netherlands.

Abstract: Emergency vehicles are increasingly dependent on ICT systems. Public safety responder's need is to enhance mission critical voice with broadband data. Command and control applications aboard a vehicle are commonplace. There is a need to ease situational awareness and decision making by using cameras and sensor information. However, countries and user organizations are developing own solutions according to their legislation and requirements, because uniform standards are missing. This paper is a kick off for creating a common international ICT infrastructure for all emergency vehicles. This design research study concentrates on the data communications layer representing a tested prototype for a new multichannel data communication concept based on the Distributed Systems intercommunication Protocol (DSiP). This study is a part of a larger R&D project, aimed at starting development of standards used by like-minded countries and possibly with EUROPOL and FRONTEX.

Ahokas' Master's thesis (2013) describes solutions for integrating PSC and SCADA (Supervisory Control and Data Acquisition) communications for power stations. The idea is that SCADA and PPRD communications use the same network.

Ahokas, J. (2013) Secure and Reliable Communications Solution for SCADA and PPRD use. Master thesis. Theseus. Espoo: Laurea.

Abstract: Public Protection and Disaster Relief (PPDR) and Supervisory Control and Data Acquisition (SCADA) systems have similar needs for secured and reliable communications. All European PPDR organizations have similar requirements. A common network for both PPDR and SCADA creates synergy and makes interoperability within systems and cross borders possible. This report presents a

highly redundant and secured communications network solution for both of the actors. The network level is shared between multiple actors but all communications can be secured and isolated from the other types of traffic.

Uninterrupted power distribution is extremely vital for modern society to function. Secured data transfer between control centers and power stations is critical for controlling and protecting power distribution. For added security live video stream is needed for monitoring the power stations. Current communications networks used with SCADA do not offer required features for transferring video stream in the same network as SCADA control commands.

A standard Internet connection does not offer the required reliability and security level for SCADA communications. Multi-Agency Cooperation In Cross-border Operations (MACICO) project aims to produce a new way of combining multiple telecommunication channels, such as TETRA, satellite, power line communications and 2G/3G/4G networks to create a single redundant secure and faster data transfer path for usable for PPDR and SCADA systems and at the same for video surveillance systems.

In order to provide the required level of reliability the communications network must support multi-link encrypted channels and the network must be able to prioritize traffic based on predefined parameters. Distributed Systems intercommunication Protocol (DSiP) is able to offer all of these features in a single unified solution. This enables building modern cyber-secure data network for both PPDR organizations and SCADA usage.

Even if the communications channels are secured and reliable, still some issues must be considered. This research report discusses these challenges and offers solutions for these. Also alternative solutions for securing the communications channels are discussed and compared to the proposed DSiP solution.

This research report includes three international publications published in year 2012. The first and second papers cover SCADA communications and the third paper focuses on PPDR challenges. The research work followed the multimethodological IS research concept. The work was evaluated by the seven guidelines for IS design research.

4.4 Law Enforcement Authorities' Special Requirements for Data Communications

In their study, Rajamäki & Kämppi focus on how law enforcement authorities want to facilitate their combat against criminal organizations in Europe and what kind of communications challenges cross-border operations bring. The study is a continuation of the SATERISK (SATEllite positioning RISKS) research project and focuses mainly on satellites in cross-border operations. Satellite positioning has been used for blue force tracking (tracking of LEAs' own vehicles) and for forensics. The complex tracking systems are open to all kinds of data delivery problems and even cyber-attacks. The current tracking devices are not intelligent; they can take orders but cannot self-react. Since organized crime does not respect national borderlines, there is a need for European collaboration when it comes to LEAs. This also has effects on LEAs' vehicles.

Rajamäki, J. & Kämppi, P. (2013). *Mobile Communications Challenges to Cross-border Tracking Operations Carried out by Law Enforcement Authorities. The International Conference on Information Networking 2013 (ICOIN 2013). 27.-30.1.2013, Bangkok, Thailand.*

Abstract: Organised crime is a real cross-border threat with the emergence of international warehouses of crime. For improving their evidence-gathering abilities, law enforcement authorities (LEAs) are constantly seeking new technological recording, retrieving and monitoring solutions that would facilitate their combat against criminal organisations. The criminals' counter measure activities, such as electronic counter-surveillance, jamming and constant changes in behaviour for preventing eavesdropping or physical surveillance are continuously increasing. The pressure to find new intelligent technologies, which are harder to detect, more strongly encrypted, longer-lasting, quicker to install and more adaptive, is emerging and is a high-priority task. The aim of this study is to provide an improved understanding of the structural characteristics and the dynamic evolution of mobile communication challenges to cross-border satellite-based tracking operations carried out by LEAs. The study is based on the results and lessons learned from the SATERISK research project executed 2008–2011. The study results will be exploited in the ongoing 2.5 years research project Multi-Agency Cooperation In Cross-border Operations (MACICO).

The point of the studies by Savolainen (2013) and Husso (2013) are to find out how to build a functioning camera network for police in siege incidents. The solution must be fast and easy, without help from an ICT expert. Solutions based on a wireless local area network (WLAN) were found to be too unreliable. One solution is a wireless mesh network (WMN) based on standard 802.11s. The WMN network is a wireless data network that is composed of radio links and which creates a mesh formation. The difference with a traditional wireless network is that every appliance in a mesh network can route arriving packets forward, automatically creating the radio connection. In long-lasting situations, wired connections have many advantages.

Savolainen, S. (2013). Liikkuvan kuvan siirtäminen poliisin tilannejohdon käyttöön piiritystilanteessa (Utilizing video surveillance to support police on scene commanding). Thesis. Theseus. Espoo: Laurea (in Finnish).

Abstract: The purpose of this thesis was to search for options to build a functional video surveillance network to support police on scene commanding during siege incidents. In the initial phase of the thesis project there were no specific technologies or solutions available that would suite the police needs. The objective was not to build a concrete surveillance network, but instead to find options for Police Technical Centre to consider as a complete solution. Neither was there any budget available to buy physical devices at this stage. During this research it was required to take into consideration some real life features like a rapid development of an on scene situation, end user-friendliness and feasibility in field conditions

The research method applied in this study was design science research that aims at planning a practical implementation. The applied data collection method was literature research that contained in this case mostly looking for relevant data in the internet. Because of using mostly electronic sources a critical review was a vital part of this thesis project. During the study process it appeared that it is meaningful to concentrate on mesh-networks based on IEEE standard 802.11s. Mesh-networks is a relatively new research topic and there are few printed publications available.

Available network solutions were surveys covering operator networks, wireless LAN and mesh-networks. Mesh turned out to be the most reliable option and the further research of video surveillance solution was based on this decision. Among all alternatives an American AgileMesh was selected as the best choice. AgileMesh has developed a wide set of camera tools targeted for policy SWAT activity and the communication solution is designed based on IEEE standard 802.11s.

Husso, J. (2013). Autonominen videokuvan siirtoon soveltuva tietoverkkoratkaisu viranomaisajoneuvoihin (Autonomous video transmission network for government vehicles). Thesis. Theseus. Espoo: Metropolia (in Finnish).

Abstract: This thesis aims to describe the effects of field operations on video transmission. Under field conditions, the functionality of data communications requires special attention. Problems in data connections may lead to material losses and in the worst case prevent saving human lives.

The thesis examines different methods of transferring image between two vehicles. In detail, four different data transmission methods are compared; two cable implementations and two wireless versions. Problems and challenges are

approached from a theoretical aspect. Specific implementation solutions are compared and their strengths and weaknesses are demonstrated.

There are numerous different aspects that affect wireless LAN (WLAN) performance in field conditions. These aspects include the weather, infrastructure and terrain. For this reason, a wireless LAN cannot be considered as the primary option for video transmission. These concerns were proven justified via attenuation measurements of the WLAN signal.

Nevertheless, WLAN may be used in forming a close range network around the vehicle, for example to connect cameras, computers and PDAs. For longer range video transfer it could be determined that a domestic Ajeco Ltd 4Com multi-channel router is an adequate device.

It can be concluded that in order to provide stable, reliable and secure data transfer between vehicles, it is necessary to use wired connections. Wired connections are slower to setup than wireless connections, but wired connections are clearly a better choice due to the numerous challenges that are encountered with wireless connections. For future research it would be worthwhile to study the possibilities of long-distance wireless communication methods such as Wi-MAX.

The above-mentioned studies concentrate on information security, law enforcements, and observing criminals (with satellites or video cameras). Finnish police as well as other European LEAs want technologies that are quick to install in order to catch criminals. Both studies also transfer information for law enforcements, whether it is video footage of siege incidents for police or for recording, retrieving and monitoring solutions for LEAs that would facilitate their combat against criminal organizations.

4.5 Voice Communications

This chapter deals with voice communications based on the TETRA (Terrestrial Trunked Radio) standard and consists of five student-driven theses. The main topics of the first thesis (Erkkilä & Sillanpää, 2013) are VIRVE's (viranomaisradioverkko) usability, users and development. The second thesis (Laakso & Leino, 2011) is research on the safety of the TETRA radio network system. The third thesis (Kirstinä & Lehtinen, 2012) concentrates on the use of the VIRVE radio as a tool used by emergency response nurses. Maijala & Markkanen (2012) develop VIRVE education for bachelors of social service. And the last thesis (Huhtala & Kauppila, 2011) tells about the making of a demonstration video of VIRVE and the TETRAsim training program based on interviews.

The VIRVE radio network and communication system is designed for public safety officials in Finland. VIRVE has 31,000 users, which includes the police, rescue departments, defence forces, health care and social services. Its goal is to provide national, secure and reliable communications between authorities. VIRVE is based on the TETRA network standard.

TETRA supports both voice and data transmission. TETRAsim is a Finnish provider of the TETRA simulating environment and training programs.

The purpose of Erkkilä & Sillanpää (2013) is to clarify the type of communication used in a VIRVE network and how it could be developed. The method used was a literature review, and 14 studies were used for the final review. The findings show that VIRVE improves the communication between authorities and makes it faster. It is secure in use. Results show that group calls were used a lot. However, room for improvement was found. Call groups were considered to be hard to use, there is a lack of education in their use, there are no clear communication instructions, and there were some grievances. The group call was the most-used function, and it needs the most improvement. The conclusion is that there are more advantages than disadvantages when using VIRVE. The results consisted of many benefits in using VIRVE. The user must be aware of the message traffic rules and traffic discipline.

Erkkilä, H. & Sillanpää, L. (2013). Viestintä VIRVE-viranomaisradioverkossa ja sen kehittäminen: Kirjallisuuskatsaus (Communication in public authority radio network VIRVE and its development). Thesis. Theseus. Espoo: Laurea (in Finnish).

Abstract: VIRVE is a communication system which is designed for public officials use. The users are: rescue departments, the police, the Finnish defence forces and health care and social services. The total number of users is 31 000. Since the beginning of VIRVE the main focus has been ensuring the consistent and secure communication between public authorities.

The purpose of this thesis was to find out what type of communication is used in VIRVE network. The main target of the thesis was to develop VIRVE-communication. The thesis was carried out as a literature review. The total amount of studies which were chosen to final review was 14. The chosen studies dealt the use of VIRVE in fire department, the police and health care and social services. The data was analyzed by inductive content analysis.

According to the findings, the use of VIRVE enhances public authority communication, increases security and enables faster communication and preindication. VIRVE also serves as a communication tool for the management and it obligates the user to responsible ways of communication. In the studies, group calls was often used as a way of communication. Based on the findings of this thesis, the main areas that need improvement in VIRVE are: the call groups, handling and use, training, procurement, communication guides and the terminal device. VIRVE call groups were found to be the area that needed the most improvement.

In future studies the terminology that is used in VIRVE communication could be studied further because it proved to be difficult to understand. VIRVE communication involves many instructional guides which are essential to manage

in order to succeed in VIRVE communication. In the future an orientation folder of different user communication guides could be gathered.

Laakso & Leino (2011) research the security of the TETRA standard and its communication requirements for authorities. Their study focuses on wireless communication risks and a comparison of TETRA to other radio and mobile phone systems. The conclusions of the thesis are that TETRA is the most secure and usable alternative. Its properties are very diverse and comprehensive for authorities to use. TETRA phones combine radio and mobile phone functions, for example, one-way and two-way voice calls, emergency calls, the search of groups in a coverage area and in the direct mode. TETRA's encryption is strong, it works in both directions, mobile devices can be removed from the network temporarily or permanently, and it is operational. New commercial mobile networks are highly developed with their safety features, but they do not reach TETRA's level.

Laakso, J. & Leino, H-H. (2011). TETRA--radioverkkojärjestelmän turvallisuuden tutkimus teknisen vertailun ja riskianalyysin avulla (Research of the security of the TETRA radio network system with the help of a technical comparison and a risk analysis). Thesis. Theseus. Espoo: Laurea (in Finnish).

Abstract: This thesis studies the suitability of the TETRA (Terrestrial Trunked Radio) radio net-work standard to the communicational requirements of authorities such as the police, fire brigades, rescue services, social and health care organisations. The many risks posed by wireless communication technology are also researched. Additionally the most commonly used radio and mobile phone systems are covered. Their technical aspects are compared with the properties offered by the TETRA network. A risk analysis is used to estimate the consequences of the probability and severity of the risk factors. This study is commissioned by Laurea University of Applied Sciences and is a part of the risk studies of communication technologies belonging to the MOBI project.

In this thesis TETRA and the other radio and mobile phone systems have been examined according to the literary publications and online documentations concerning them. The theoretical knowledge included in the sources is presented coherently with the technical comparison and the risk analysis in mind. The technical comparison has been made by composing the literary sources into a generalised table in which the features of the systems studied are compared with the TETRA system.

The technical comparison supports the risk analysis for which the risks are collected from both literary and online sources, including many news articles reporting real life incidents. The implementation of the risk analysis was done by creating a risk analysis tool to which the required degrees of probability and severity were acquired with a form filled by an expert of the field. The risk degrees are presented numerically in the table and conclusions are drawn in light of their frequency in the activities of a health care organization.

Based on the results of the research, the TETRA standard is the most secure and usable alternative as a whole out of the radio and mobile phone systems available today for the use of authorities, especially when services for voice calls were considered. The operation of TETRA proved to be reliable in both uncertain situations and in risk-prone operational environments as well, because it is available for limited usability in circumstances where the other researched systems would be practically almost or entirely inoperable. This thesis can assist decision making for organisations that consider improving their mobile communications system to a more secure and reliable direction based on the current technologies available.

4.6 End-user Training for TETRA

The following three theses made research on different points of view toward TETRA training. The study of Kirstinä & Lehtinen (2012) was a quantitative research with a 19% response rate. The purpose of the thesis was to describe the VIRVE training needs of nurses at the Meilahti emergency room and the Töölö accident & emergency facility. Also, one of the goals was to develop the VIRVE radio training program based on this research. It was concluded that there is a clear need for VIRVE training from the beginning with basic use. Also, the official communication skills of authorities should be included in the education.

Kirstinä, T. & Lehtinen, S. (2012). *Virve-puhelin sairaanhoitajan työvälineenä päivystys-alueella (The use of Virve radio as a tool for the ER nurses)*. Thesis. Theseus. Espoo: Laurea (in Finnish).

Abstract: The Finnish authority radio network (Virve-network in Finnish) is a part of the national communication safety network that was produced to provide the authorities a national, reliable and secure radio network. The network design was started in the early 1990s and the construction began in 1998. It became nationwide in 2002. The users of the Virve network include the defense forces, rescue, security and health authorities. Virve equipment is used in the secure internal and external communication and data transfer between different authorities. The use of Virve in the social and health care area is increasing. In order to make sure the health care professionals' radio communication skills comply with fulfil the requirements, it is important to receive feedback from the everyday users of the Virve network.

The purpose of this study was to describe the Virve-radio training requirements of the nurses in Meilahti emergency room and Töölö accident & emergency. The purpose was also to further develop the Virve-radio training program according to the results of the questionnaire conducted on the nurses.

A quantitative research method was used in this thesis. The response rate was 19%. A structured questionnaire was used to gather the data and it included of 24 questions or claims. According to the theoretical background, the use of Virve and

the length of experience in its use, the knowledge of its use and the training needs for the user were separated as the different areas in the questionnaire. Based on these different areas, the purpose was to find out what different qualities of the Virve radio were used and how. The general opinion regarding the radio, the ease of its use, the benefits of its use and the technical knowledge and skills of its users were also studied. In addition, the benefits and the necessity of the Virve radio training were studied, as well as the opinions on where and how the training should be organised. The analysis of the questionnaires was carried out using an Excel-spreadsheet program and a calculator.

According to the results the knowledge of the use of Virve radio varies greatly. In addition, the study showed the need for annual training. The training should focus on the basic skills and ordinary communication skills. The majority of the respondents would prefer the training to be conducted in their own work site.

The thesis of Maijala & Markkanen (2012) deals with bachelors of social work and their VIRVE use in education. VIRVE was seen as a tool that could improve cooperation in the future. Bachelors in Social Work cooperate a lot with different authorities, and VIRVE could facilitate working together. At the moment, emergency communications go through the emergency centre, but in the future, calls could connect directly, without intermediaries. VIRVE education is inadequate, but VIRVE is a new concept and still needs improvements.

Maijala, M. & Markkanen, J (2012). Sosionomiopiskelijoiden Virve-koulutuksen kehittäminen (Developing the Virve education for Bachelors of Social Service). Thesis. Theseus. Espoo: Laurea (in Finnish).

Abstract: Virve is an authority radio network which allows safety authorities to communicate with each other. It is used by, for example, the police, rescue services, paramedics, emergency clinics and on duty social workers. There are approximately 31 000 Virve users and its use in the communication between authorities is increasing. There is a growing demand for Virve education. Currently, Virve education is provided mostly for health care workers but as the use of Virve increases, social services employees will have to be trained to use it as well.

A Bachelor of Social Services is a University of Applied Sciences graduate. Completing the education takes 3.5 years. Bachelors of Social Services have diverse employment opportunities and they can work, for example, in child protection, mental health services or as home care supervisors.

The purpose of this thesis was to explore the possible uses of Virve in the work of Bachelors of Social Services. The objective was to develop the Virve education for students of social services. The research method was qualitative and the data was collected through three theme interviews. In order to obtain different perspectives on the subject, we interviewed a student and a teacher of social services and a Bachelor of Social Services working at a social emergency center. Research data was analyzed by using content analysis.

According to the findings, Virve education was perceived as useful for students of social services. Bachelors of Social Services work together with different authorities and using Virve in the communication between authorities could be useful. Virve could be of use in particular in urgent crisis situations where quick communication is necessary.

As this thesis was written by nursing students, further research could involve students of social services conducting research on Virve and Virve education from their point of view. Future research could also involve increasing the co-operation between students of nursing and social services and improving the communication between different authorities.

The last thesis (Huhtala & Kauppila, 2011) produced a screenplay for a demonstration video based on interviews from various authorities that are using VIRVE. The aim is to give more information about the communication system and to motivate viewers to participate in the training program. The research indicates that there is a need for more education and training in VIRVE.

Huhtala, R. & Kauppila, P. (2011). VIRVE ja TETRAsim-koulutusympäristö — esittelyvideo (VIRVE and TETRAsim training program — demonstration video). Thesis. Theseus. Espoo: Laurea (in Finnish).

Abstract: In Finland, TETRA (terrestrial trunked radio) goes by the name viranomaisradioverkko or VIRVE, meaning government radio network. VIRVE is Finland's most comprehensive digital TETRA standard-based network, which is intended for communication between authorities. The purpose of this thesis was to produce a demonstration video about VIRVE and the TETRAsim training program. The video aims to give information about the government radio network and to motivate viewers to participate in the training program. A person can receive TETRAsim training at Otaniemi unit of Laurea University of Applied Sciences where a simulation learning environment has been created for this purpose. The development of this training program has been carried out together with the Helsinki — Uusimaa Hospital district.

VIRVE users were interviewed in various work environments for the screenplay of the video. The interviewees include a firefighter, a paramedic and two nurses from the on-call area. The interviews were semi-structured thematic interviews designed to identify the use and experience of VIRVE in the workplace and the role and importance education to use it. The core content of the analysis of the material indicates that there is a need for more education and training of the VIRVE system.

The script of the video consisted of the following themes: the role of the government radio network, experiences of its use and training. The locations in the video were the Niittykumpu fire station, the casualty ward in Töölö and Laurea

Otaniemi. Firemen, paramedics, nurses and students of Laurea were invited to be the actors and actresses in the video. The video can be used for marketing and educational purposes.

Basically, all the theses show that there is a lack of information. Guidance in usage is poor, and the system includes some functions they do not need. With standardization in communication and development, a network system can provide desired results. As mentioned earlier, VIRVE's usability is managed by a few, and with more education this communication system for authorities can be improved to the level it should be.

References

Ahokas, J. (2013). Secure and Reliable Communications Solution for SCADA and PPDR use. Master thesis. Theseus. Espoo: Laurea.

Ahokas, J., Rajamäki, J. & Tikanmäki, I. (2012). "Secure and Redundant Public Safety Communication Network for Public Protection and Disaster Relief (PPDR) Organizations", International Journal of Communications, Issue 3, Volume 6, pp. 120-127.

Alaverronen, S. (2012). Liikennemäärien visualisointi Javalla DSiP-lokitiedostoista. Thesis. Theseus. Espoo: Laurea (in Finnish).

Bertling, M. (2011). Kytcentöjen määrän visualisointi Javalla DSiP-lokitiedostoista. Thesis. Theseus. Espoo: Laurea (in Finnish).

Erkkilä, H. & Sillanpää, L. (2013). Viestintä VIRVE-viranomaisradioverkossa ja sen kehittäminen: Kirjallisuuskatsaus. Thesis. Theseus. Espoo: Laurea (in Finnish).

Holmström, J., Rajamäki, J. & Hult, T. (2011). DSiP Distributed Systems intercommunication Protocol - A Traffic Engineering Solution for Secure Multichannel Communication. 10th WSEAS International Conference on Applications of Computer Engineering, March 24-26, 2011, Playa Meloneras, Gran Canaria, Canary Islands, Spain.

Huhtala, R. & Kauppila, P. (2011). VIRVE ja TETRAsim-koulutusympäristö — esittelyvideo. Thesis. Theseus. Espoo: Laurea (in Finnish).

Kirstinä, T. & Lehtinen, S. (2012). Virve-puhelin sairaanhoitajan työvälineenä päivystysalueella. Thesis. Theseus. Espoo: Laurea (in Finnish).

Laakso, J. & Leino, H-H. (2011). TETRA--radioverkköjärjestelmän turvallisuuden tutkimus teknisen vertailun ja riskianalyysin avulla. Thesis. Theseus. Espoo: Laurea (in Finnish).

Maijala, M. & Markkanen, J. (2012). Sosionomiopiskelijoiden Virve-koulutuksen kehittäminen. Thesis. Theseus. Espoo: Laurea (in Finnish).

Rajamäki, J., Holmström, J. & Knuuttila, J. (2010). Robust Mobile Multichannel Data Communication for Rescue and Law Enforcement Authorities. 17th IEEE Symposium on Communications and Vehicular Technology in the Benelux, November 24-25, 2010, University of Twente, The Netherlands.

Rajamäki, J. (2012). Decentralized cyber secure public safety communications and information management systems for a multi organizational environment. Plenary Lecture 2. The 3rd International Conference on Energy, Environment, Devices, Systems, Communications, Computers (INEEE'12), Rovaniemi, April 18-20.

Rajamäki, J. & Kämppi, P. (2013). Mobile Communications Challenges to Cross-border Tracking Operations Carried out by Law Enforcement Authorities. The International Conference on Information Networking 2013 (ICOIN 2013). 27.-30.1.2013, Bangkok, Thailand.

Savolainen, S. (2013). Liikkuvan kuvan siirtäminen poliisin tilannejohdon käyttöön piiritystilanteessa. Thesis. Theseus. Espoo: Laurea (in Finnish).

Ukil, E. (2013). Field testing for verifying a multichannel data communication concept for emergency vehicles. Thesis. Espoo: Laurea

Vilpas, M. (2012). Javan soveltuvuus DSiP-reititysjärjestelmän asetusmuokkaimen luontiin. Thesis. Theseus. Espoo: Laurea (in Finnish).

5 Towards Common Services

Jyri Rajamäki, Paresh Rathod & Ilkka Tikanmäki

Public Protection and Disaster Relief (PPDR) services, including police forces, fire brigades, ambulance services, maritime and coast guard services, are the primary protectors of life and property. We have learnt from previous chapters that the amount of technical applications and services in PPDR vehicles has increased during the past few decades. The lack of common standardization in this field resulted in a multiplicity of ICT infrastructures. It is important to create a common ICT infrastructure for all emergency vehicles, which was one of the main reasons why the MOBI (Mobile Object Bus Interaction) project was founded and extensive studies were conducted. The project outcome also includes various recommendations for standardization, including piloting concepts. This chapter mainly focuses on common services in PPDR services, and the following sections summarize the samples of evidence in the studies.

5.1 Introduction

The first article in this section, "Designing an emergency vehicle ICT integration solution", written by Jyri Rajamäki and Timo Villemson, presents ICT solutions for emergency vehicles produced by the Internal Security ICT Agency (HALTIK). In the article, Rajamäki and Villemson express their concern about the diversity of the ICT systems used in emergency vehicles. They also pointed out that different services are constructed through multiple providers perpetuating the interoperability issues between ICT systems. The main goal for this study is to illustrate design parameters and features of ICT integration. One example that Rajamäki and Villemson present is that all services should be acquired through a single provider. A new mobile platform for police cars is also proposed.

Rajamäki, J. & Villemson, T. (2009a). Designing emergency vehicle ICT integration solution, In proceedings the 3rd International Conference on Communications and Information Technology, 29-31 December, Athens, Greece.

Abstract: E.g. Finnish police cars have about 40 different user interfaces (radio, navigation, command and control systems, radar, alarm lights etc.) on the deck beyond cars' user interfaces. In cold weather conditions, all police vehicles are not creating enough electricity for intensive operations. Also, wiring and ergonomics are problematic. However, the annual delivery amount of emergency vehicles is so

low that traditional business models being made up of selling of devices and systems do not inveigle suppliers into doing remarkable developing work. So, other business models, such as digital service concepts, are needed also for security services. In this paper, the concept vehicle is a Volkswagen transporter used by the Finnish police, but the possibility of extensibility to other emergency vehicles is also discussed. A new mobile platform for police cars is proposed and the digital service design parameters of the ICT solution are defined. Further research subjects are also presented.

Our studies on PPDR services clearly found that organizational changes bring potential challenges for all services to their audience. Hanna-Miina Sihvonen has conducted her doctoral studies reviewing the organizational changes and how to improve software processes. Her thesis is titled, "Studies on Software Process Improvement in Organizational Changes". She has awarded a PhD degree, and her thesis abstract is presented below.

Sihvonen, H-M. (2012). Studies on Software Process Improvement in Organizational Changes. Doctoral Thesis. University of Eastern Finland. Publications of the University of Eastern Finland, Dissertations in Forestry and Natural Sciences No 72.

Abstract: Organizational changes, such as mergers and acquisitions, reconfigurations, growth, internationalization, outsourcing, and adoption of standards or process improvement frameworks, have notable effects on software processes. The changes strongly affect organizational structures and processes, organizations' business models, product and service portfolios, and technology platforms. Moreover, they cause difficulties in process improvement work or enforce the organization to initiate process improvement actions.

The main objective of this thesis is to answer the research problem, how organizational changes affect software process improvement. The main research method of this thesis is case study. The studied cases cover different types of organizational change situations and process improvement activities.

The main contribution of this thesis is 1) to strengthen the existing knowledge and provide new insights on impact of organizational changes to software process and 2) to increase understanding of software process improvement challenges in organizational changes. The main practical contribution of this thesis concerns the empirical experiences on software process improvement in organizational changes and how to support software process improvement work with training.

These contributions can be used in practice by software organizations' business managers, software process and quality managers, and software engineers to prepare for organizational changes, which have effect on software processes.

5.2 Human-Machine Interactions

During the MOBI project work, we explored human-machine interactions and interfaces, and we also piloted a few of them. The study by Rajamäki et al. (2014) combined the assignments of Master's students Timo Timonen, Jenni Nevalainen, Heli Uusipaavalniemi, Tomi Töyrylä and Eero Arte, along with other results of the MOBI project with respect to human-machine interactions.

Rajamäki, J., Timonen, T., Nevalainen, J., Uusipaavalniemi, H., Töyrylä, T. & Arte, E. (2014). Human-machine interactions in future police vehicles: Applying Speech User Interface and RFID Technology, International Journal of Systems Applications, Engineering & Development, Volume 8.

Abstract: A modern police vehicle is a very complicated combination of different technologies. A single vehicle contains dozens different human-machine interfaces (HMIs) and carries a lot of equipment; for example, Finnish police cars are equipped with an average of about 40 different HMIs and 100 different types of equipment. It is extremely important to be sure that all needed tools are available in field operations. From operational, safety and ergonomic reasons, there is a need to cut down the number of HMIs and make the systems easier and safer to use. This paper presents results from the MOBI project (<http://mobi.laurea.fi>) with regard to human-machine interactions in future police vehicles. The findings show the significance of the early user feedback for the design work of HMIs. The results also show that a remote identification applying RFID technology enables the police to make the inventory of their vehicles' equipment three times faster than by hand. Based on our study, there is a global need for a standard in the HMI design for emergency service vehicle development.

5.3 Towards Design Principles of Service-Oriented Architecture (SOA)

The Public Protection and Disaster Relief (PPDR) organizations are using Information and Communication Technology (ICT) services in very heterogeneous and customized delivery methods. The majority of organizations have tailored processes, contracts and technologies. In many cases, these are managed by internal and external suppliers. The design principles of Service-oriented Architecture (SOA) can be the answer to leveraging the benefits of existing software, interoperability and flexibility of integration. The SOA approach brings many benefits for emergency response organizations to deal with public protections and disaster relief operations. The first benefit is the reuse of existing services and the encapsulation of legacy systems. The second benefit is the agility to change processes and information flows to support any changes. The third benefit is the ability to monitor points of information and service in real time. This monitoring allows checking and determining the state and well-being of emergency services. The fourth benefit is the extended reach and ability to expose certain required processes to other external entities for the purpose of

interoperability, cooperation or shared processes. Service-oriented solutions can be comprised of services built as web services, components, or a combination of both.

The first study in this section by Rajamäki and Villemson (2009b) proposes a new mobile platform for police cars as well as the digital service design parameters for the ICT integration solution.

Rajamäki, J. & Villemson, T. (2009b). Creating a service oriented architectural model for emergency vehicles. *International Journal of Communications*, Issue 2, Volume 3, 44-53.

Abstract: E.g. Finnish police cars have about 40 different user interfaces (radio, navigation, command and control systems, radar, alarm lights, etc.) on the deck beyond the cars' standard user interfaces. In cold weather conditions, not all police vehicles are creating enough electricity for intensive operations. Also, wiring and ergonomics are problematic. The annual delivery amount of emergency vehicles is, however, so low that traditional business models, where devices and systems are sold to the end-user, do not motivate suppliers to do invest significantly in system development. Therefore, other business models, such as digital service concepts, are needed for security services. In this paper, the concept vehicle is a Volkswagen transporter used by the Finnish police, but the possibility of extending this concept to other emergency vehicles is also discussed. A new mobile platform for police cars is proposed, and the digital service design parameters of the ICT integration solution are defined. Further research subjects are also presented.

The second study by Rajamäki, Hult and Ofem (2011) deals with some of the fundamentals in Public Protection and Disaster Relief services. The article describes ICT systems used in Finland in the field of fire and rescue services. They point out that the number and diversity of technical devices, combined with the lack of standardization and poor documentation, has generated problems in the field. There have been issues related to safety systems, power consumption and interoperability between various ICT systems, to name a few. Rajamäki, Hult and Ofem propose to enact Service Oriented Architecture and its standards as a basis of business services and system development in PPDR vehicles, which could enable the amalgamation of heterogeneous systems and improve interoperability.

Rajamäki, J., Hult, T. & Ofem, P. (2011). ICT integration of public protection and disaster relief: services for fire and rescue personnel, *International Journal of Computers and Communications*, Issue 3, Volume 5.

Abstract: In field operations of Public Protection and Disaster Relief (PPDR) services, vehicles are the most important tools. Today, the vehicles are increasingly dependent on ICT systems. PPDR responder's need is to enhance mission critical voice with broadband data. Command and control applications aboard a vehicle are commonplace. There is a need to ease situational awareness and decision making by utilizing sensor information, such as satellite or network based position

information, living video images. However, each country and even every single user organization is developing their own solutions according to their legislation and requirements, because uniform standards are missing. The Mobile Object Bus Interaction (MOBI) research project is a kick off for creating a common international ICT infrastructure for all PPDR vehicles. MOBI researches possibilities to further develop and integrate ICT systems, applications and services of PPDR vehicles. MOBI aims at starting the development of standards used by like-minded countries and possibly with the European Commission, the European Law Enforcement Agency EUROPOL and the European Agency for the Management of Operational Cooperation at the External Borders FRONTEX. This paper concentrates on services for fire and rescue personnel and researches the Finnish fire and rescue environment and the ICT systems used in action. PPDR services constitute a distributed system. Software development paradigms which have been used in the past for distributed systems have inherent limitations that do not support integration, interoperability and reusability. To contribute towards resolving the well-known issues of integration and interoperability between ICT systems in emergency vehicles which often work in a collaborative fashion, a preliminary investigation of the applicability of SOA and Web Services Standards towards the optimization of ICT systems and services provided by emergency vehicles is presented.

It would be rather helpful to learn the background and basis for research study on User Centred Requirements in the MOBI project. Jyri Rajamäki, the director of the MOBI project, was keen to explore the research area of standardization in ERVs. He started to supervise some research studies and thesis work. The entire research exploration ended up forming a wider project ecosystem with MOBI as part of that ecosystem. Rajamäki has successfully published many international publications with an able research team. Amongst them was an early work carried out by Taina Hult starting in 2009. Her thesis work has been stretched to a long period from 2009 to 2012. However, it is one of the foundations of the MOBI project. Studying her abstract would give readers a brief background, as mentioned before.

The study, "Public Protection and Disaster Relief services ICT-systems developing and integration", written by Taina Hult, points out how mission critical communication and system integration and interoperability could be improved in field operations of Public Protection and Disaster Relief services. Hult depicts that DSiP covers the demands of mission-critical communication between PPDR services. DSiP uses a variety of communication channels and resources in parallel and works in a multi-operator environment. Service Oriented Architecture is proposed as the basis for integration between applications on different platforms used in emergency vehicles.

Hult, T. (2012). Turvallisuus- ja pelastusviranomaisten ICT-järjestelmien kehittäminen ja integraatio. (Public Protection and Disaster Relief services ICT-systems developing and integration). Thesis. Theseus. Espoo: Laurea (in Finnish).

Abstract: In field operations of Public Protection and Disaster Relief (PPDR) services, vehicles are the most important tools. The number of technical devices and applications in vehicles has increased considerably, which has generated different technical problems e.g. in vehicles security systems. Power consumption has also increased, which generates new problems and pressure to reduce power consumption. Documentation of the solutions applied is varied and there has been no standardization in the field.

MOBI (Mobile Object Bus Interaction), a three-year project led by Laurea University of Applied Sciences and funded by Tekes, started in September 2010. The purpose of this project is to create a common ICT hardware and software infrastructure for all emergency vehicles. The aim of the project is to develop product concepts which have potential in both domestic and export markets. The main objective of this project is to create standardization in this field which enables exporting a commercial product including commercializing plans to be offered in the European market. The programme consists of two industrial projects and a research project led by Laurea University of Applied Science. The research project generates relevant research data for the industrial project. From the results of the research a demo vehicle with workable ICT-systems integration will be made.

This thesis is part of the research project and it describes needs and requirements of PPDR mission critical communication in surveillance situations on land, at sea and in the air. It will present one traffic engineering solution for secure communication and one software architecture paradigm which enables system integration.

This research work followed the multi methodological approach created by Jay Nunamaker for information system research. In the multi methodological approach theory building, observation, experimentation and systems developing phases are integrated during the research process. The conclusive research report consists of four international publications published in 2011.

The publications cover PPDR's mission critical communication, multichannel routing communication and service oriented computing based software architecture paradigm for system integration. DSiP communication system enables routing data over any kind of connection (IP and non-IP) and works in multi-operator environments applying satellites, 3G, GRPS, UMTS, HDSPA, IPnetwork, TETRA, serial connections and radio modems. Customers can use multiple communication channels in parallel in such a way, that ending peers "think" they are using one channel. SOA paradigm enhances fire and rescue departments ICT systems usability, performance, scalability, reliability, availability, extensibility, maintainability, manageability and so on. With these two presented solution we could achieve objectives of MOBI project.

The Master's thesis, "Investigating the Role of Service-Oriented Architecture as an Enabler of ICT Integration and Optimization in Public Protection and Disaster Relief Services — A Case Study of Medical Emergency Services in Finland", written by Paulinus Ofem,

investigates SOA usability in the integration of ICT systems and services provided in medical vehicles. Ofem describes SOA concepts in general and introduces current systems and services used in medical emergency vehicles. The service-oriented architecture model is proposed for the emergency vehicles and control centre. According to research, there are some major issues to be solved before implementing the SOA model. The study shows that no formal cooperation between ICT system providers exist. Mr Ofem realized that the lack of cooperation between ICT system providers has led to security and management concerns. An unwillingness to share information between providers is a barrier for improving interoperability of EMV systems. Ofem proposes that there should be legislation for enabling agencies to cooperate. After the issues are solved, it is feasible for SOA to be implemented as the model for ICT integration. Paulinus Ofem reminds us that adoption of SOA should be seen as a strategic long-term investment. SOA is an integrating architecture that is quite complex, and it would take time to be successfully adopted in the research domain.

Ofem, P. (2011). Investigating the Role of Service Oriented Architecture as an Enabler of ICT Integration and Optimization in Public Protection and Disaster Relief Services - A Case Study of Medical Emergency Services in Finland. Master Thesis. University of the West of Scotland.

Abstract: There is a known global initiative to improve health care services using Service Oriented Architecture (SOA) and Web Services. The health sector has witnessed the introduction of computer decision support systems and technologies to enable the attainment of an effective healthcare system. The emergency medical services (EMS) is a unit in the health sector of which services are always pressurised due to emergencies which could warrant calls for desperate ICT systems and services to function efficiently and effectively. However, the decision support systems so far introduced have been based on software development approaches and architectural philosophies of which inherent limitations do not adequately tackle the growing pressure on the health care services such as the emergency services and the integration of systems that support such services. These systems are to a large extent not interoperable and do not support agility, reusability and integration owing to the approaches that gave birth to them. Since the Health Services is moving towards the adoption of SOA and Web Services, we aim to investigate the applicability of SOA and Web services standards towards the integration and optimization of ICT systems and services provided by emergency vehicles and control centres. We propose a SOA model for use in medical emergency vehicles and their control centres together with a conceptual innovative service blue print for the domain. The idea therefore is to address issues of ICT integration, interoperability and support for information inter-change within the domain. The research findings suggest that, a SOA solution is feasible in the problem domain and standards-based interoperability and integration can be achieved.

Another Master's thesis by Jouni Lehto, entitled "Improve the rescue work at the shadow region and how the cloud computing can be used to improve the rescue work: design research in information systems" concentrates on clarifying how to improve rescue

operation in Finland. This study describes how cloud services can be utilized in the research domain. The main objective of this research is to create the overall architectural model of the rescue operation. Mr Lehto depicts SOA as the basis for generating the cloud services to improve communication between Finnish authorities. This investigation proposes to establish a Wireless Local Area Network (WLAN) between emergency vehicles and to utilize a DSIP multichannel router to prevent the shadow region.

Lehto, J. (2012). Pelastustoiminnan parantaminen katvealueella sekä pilvipalveluiden hyödyntäminen pelastustoiminnassa: suunnittelututkimus. (Improving the rescue work at the shadow region and how the cloud computing can be used to improve the rescue work: design research in information systems). Master Thesis. Theseus. Espoo: Laurea (in Finnish).

Abstract: The Rescue Service in Finland has a major problem with the communication with the other authorities who also participate in the rescue process. The problem is that they don't have shared programs or any other e-services which they can use to communicate with each other. The cloud computing might be the answer for this problem. In this research is figured out which cloud computing deployment model and cloud service model would be suitable. How these cloud services can be provided from VIRVE IP Network nowadays and in the future are presented in this research. How the laws, regulations and guidelines effects to the application building in Finnish rescue service area, is figured out in this research.

The second biggest problem which they have is shadow regions where the rescue authorities can't get the connection to the VIRVE network. It would be better if these important programs could work locally in emergency vehicle. Enterprise Architecture which will be the result of this research, will reduce some of the problems which will come when installing the programs locally when they are not intend to work that way. How the cloud computing can be used in Finnish rescue services, is also covered in the enterprise architecture.

The Enterprise Architecture which will be the result of this research is based on the knowledge that the cloud services will be provided from VIRVE IP Network with SaaS service model. In SaaS service model the cloud subscribers only pays from the rights to use the application and the provider has the maintain responsibility. The decentralized solution is also presented in the enterprise architecture. With this decentralized solution it is possible to maintain the same information from different application without they have the same database. In this solution is utilized the new database solution called NoSQL. NoSQL is not relational database, but depend on the used implementation; it will save key-value pairs or whole documents to the database.

Jouni Lehto, Jyri Rajamäki and Paresh Rathod wrote an article, "Conceptualised View on Can Cloud Computing Improve the Rescue Services in Finland?" The research paper deals with problems generated in the field of Finnish rescue services. The biggest problem at the

moment is the weak ability to communicate between authorities who take part in the rescue process. Every authority has independently implemented their IT solutions, which has led to a multiplicity of applications. Even if different organizations have the same application or program, they might have different versions, which is what has mainly led to the situation at hand.

Lehto and colleagues propose cloud computing within the VIRVE IP network to help authorities communicate with each other. They point out that the VIRVE network cannot yet be used for data transfer from cloud services. The current transmission capacity must be increased before it can be used on day-to-day services. Service Oriented Architecture (SOA) is proposed to reduce the range of heterogeneous applications. Lehto, Rajamäki and Rathod remind us that although SOA solves the problem, there is still a lot of time and resources required.

Lehto, J., Rajamäki, J. & Rathod, P. (2012a). Conceptualised View on Can Cloud Computing Improve the Rescue Services in Finland? Proceeding of the 11th WSEAS international conference on Applied Computer and Applied Computational Science, April 18.-20, Rovaniemi, Finland.

Abstract: The Rescue Services in Finland have a significant problem of communication with other authorities who also participate in the rescue process. The greatest challenge is a lack of shared programs, applications or any other e-services which they can use to communicate with each other. The cloud computing combined with Service-Oriented Architecture (SOA) might be the answer for this problem. There are several solutions and guidelines available. This research paper explores which cloud computing deployment model and cloud service model could be suitable to address the problem along with Service-oriented approach. Further study also conducted on cloud services provided by the Public Authority Network (VIRVE) in Finland. The Cloud approach is compared to a System of Systems approach of SPIDER (Security System for Public Institutions in Disastrous Emergency scenaRios) project. The SPIDER project emphasises on enabling interoperable information sharing between public institutions for efficient disaster recovery and response. The paper presents conceptual view on usability of cloud and service-oriented computing in the disaster recovery and response services in Finland.

Another journal article by Jouni Lehto, Jyri Rajamäki and Paresh Rathod is "Cloud computing with the SOA approach as part of the disaster recovery and response in Finland". The article is an extended research work that describes service-oriented architecture combined with cloud services to improve communication and cooperation between Finnish authorities participating in the rescue process. They point out that cloud services can be offered from the VIRVE IP network as a common service. A hybrid cloud model is proposed as the most suitable way to build common services. The implementation described in this investigation was defined to cover the security requirements using the hybrid cloud model. Every authority has its own cloud protecting sensitive information. Lehto and colleagues present that Software-as-a-Service (SaaS) model is the solution to reduce the wide range of software and

to help with version control. In addition to enhancing communication between Finnish authorities, the presented hybrid cloud model combined with SOA reduces the ICT costs of the Finnish government. Service centralization in cloud services is the basis for cost savings.

Lehto, J., Rajamäki, J. & Rathod, P. (2012b) Cloud Computing with SOA Approach as Part of the disaster Recovery and Response in Finland. International Journal of Computers and Communications, Issue 3, Volume 6, 175-182.

Abstract: The Rescue Services in Finland have a significant problem of communication with other authorities who also participate in the rescue process. The greatest challenge is a lack of shared programs, applications or any other e-services which they can use to communicate with each other. The cloud computing combined with Service-Oriented Architecture (SOA) might be the answer for this problem. There are several solutions and guidelines available. This research paper explores which cloud computing deployment model and cloud service model could be suitable to address the problem along with Service-oriented approach. Further study also conducted on cloud services provided by the Public Authority Network (VIRVE) in Finland. The Cloud approach is compared to a System of Systems approach of SPIDER (Security System for Public Institutions in Disastrous Emergency scenarios) project. The SPIDER project emphasises on enabling interoperable information sharing between public institutions for efficient disaster recovery and response. The paper presents conceptual view on usability of cloud and service-oriented computing in the disaster recovery and response services in Finland.

The investigation by Rajamäki and Rathod, "Service Standardization with utility computing and service-oriented architecture as a tool for public protection and disaster relief", describes how information and communication technology services should be standardized in the field of public protection services. The ICT service field is currently heterogeneous and typically tailored by the supplier. This investigation points out that a PPDR organization should standardize their technology, contracts and processes. The ITIL framework is represented as a standard to follow. PPDR organizations should also validate their operation with contracts. LSAs and QoS agreements should be used to improve and ensure service quality. Cloud computing combined with service-oriented architecture can enhance communication and cooperation between PPDR organizations. PPDR organizations are no longer so dependent on a single supplier when ICT services are standardized. ICT services are also easier to transfer from one supplier to another in a more flexible way.

Rajamäki, J. & Rathod, P. (2013) Service Standardization with utility computing and service oriented architecture as a tool for public protection and disaster relief. Proceeding of the EISIC 2013 Conference Poster Session. August 12, Uppsala, Sweden.

Abstract: Information and Communication Technology (ICT) services are currently delivered in very heterogeneous and customized delivery methods to client organizations, especially in the Public Protection and Disaster Relief (PPDR) field. All PPDR actors have tailored processes, contracts and technologies managed by

both internal and external suppliers. The ICT service terms, processes and applied technologies have typically been fully tailored to client organizations wishes. The next ICT megatrend—utility computing combined with service oriented architecture (SOA)—is very controversial. In utility computing ICT services are highly standardized. The same services are provided for multiple clients simultaneously to any device over the network with the same terms and conditions. Suppliers have invested in automation to be able to provide each service to as many clients as possible with little or no manual work. With utility computing client organizations could achieve considerable savings, quality improvements and strategic initiatives as they would pay only based on the actual usage. The transformation journey from highly tailored service model to highly standardized services requires some careful preparations in order to succeed. SOA enables the building of new applications that provide services to all PPDR organizations, but at the same time limits access to sensitive data and enhances security. This paper studies ICT services and argues that all processes, technologies and contracts should be standardized. After that, the organizations, once developed enough, are able to benefit from utility computing. The benefits of standardization are described in detail as well some potential issues if standardization is not done.

Ofem and Rajamäki (in press) investigated Service-oriented Architecture as an enabler of cross-communications of ICT systems in emergency vehicles. Their recent article presented the results of the studies.

Ofem, P. & Rajamäki, J. (2014). Service oriented architecture as an enabler of ICT integration and optimization in public protection and disaster relief services: case study of medical emergency services in Finland, *International Journal of Computers and Communications*. [In Press]

Abstract: Current global initiative is geared towards improving health care services using service oriented architecture (SOA) and Web Services or REST. The decision support systems so far introduced have been based on software development approaches and architectural philosophies that have inherent limitations and therefore do not adequately tackle the growing pressure on the health care services such as the emergency medical services and the integration of systems that support such services. These systems are to a large extent not interoperable and do not support agility, reusability and integration owing to the approaches that gave birth to them. Since health services are moving towards the adoption of SOA and Web Services, this paper proposes a SOA model for use in medical emergency vehicles and their control centres together with a conceptual innovative service blue print for the domain. The primary idea is to address issues of ICT integration, interoperability and support for information inter-change within the domain. The paper also presents the outcome of a survey which sought to test the popularity and viability of SOA as a technology for adoption including its implementation using Web services or REST. Issues that affect the adoption and implementation of SOA and suggested ways through which they can be addressed are also presented. The research findings suggest that, a SOA solution is feasible in the problem domain and standards-based interoperability and integration can be achieved.

5.4 Security

Higher education researcher and working professional Jyri Penttinen explored the security of data terminals, one of the most critical areas in recent times. His Master's thesis investigates how to use different security-level IT service environments using the same data terminal equipment. The implementation developed in this study was defined to cover the Finnish national security audit criteria (KATAKRI) based information security sections. The solution represented by Penttinen is intended for the Windows operating system. The technical solution was accomplished using the DevCon command-line device manager utility software created by Microsoft. The DevCon script was defined in the non-encrypted master boot record, which separates different hard disks automatically during the starting process of the operating system when the end-user chooses the environment to be used. The technical solution presents the possibility of using different security-level Windows-based ICT environments in the same device that could enable a reduction in the growing number of technical devices in PPDR vehicles. The reduced number of devices will also help to solve reported problems with power consumption and cabling, also reducing the ICT costs of the Finnish government. The Windows environment is widely used by PPDR service providers, and the research work may bring broad benefits. In his Master's thesis, Pullinen highlights the growing meaning of information warfare alongside traditional warfare. The information security of nationally critical information systems (such as ISs for public safety) can be significantly improved with the defence model he presents in his study.

Penttinen, J. (2013). Eri tietoturvaluokan palveluympäristöjen käyttö samalla päätelaitteella. (How to use different security level IT service environments using the same data terminal equipment). Master Thesis. Theseus. Espoo: Laurea (in Finnish).

Abstract: This Master's Thesis investigates how to use different security level IT service environments using the same device (Data terminal equipment). In this study the requirements were defined according to the Finnish national security audit criteria called KATAKRI. Implementation was defined to cover the KATAKRI-based information security sections.

This research work has been conducted using Jay Nunamaker's multi methodological information system (IS) research framework. Nunamaker's multi methodological IS research framework integrates theory building, observation, experimentation and system developing. The framework fits to the imminent investigation problem due to the fact that there was no previous solution available. The main objective of this study was to find concrete, user-friendly and cost-effective solution.

The main challenge during this investigation was how to separate different physical hard disks from each other. Technical solution was accomplished using the DevCon command-line device manager utility software created by Microsoft. DevCon script was defined in the non-encrypted master boot record. It separates

different hard disks automatically during the starting process of the operating system when end-user chooses the environment to be used.

The solution represented in this research enables considerable cost savings. The reducing amount of devices and licenses acts as a basis for cost savings. The technical solution at hand has been approved in a security audit conducted during the research process. Production authorization was approved by the Finnish Defense Forces. Hundreds of computers have been installed to production environment using the developed technical solution.

Research results can be utilized widely in various companies and organizations that are using several security level IT environments. There is no more need to have a physical computer for each environment. Instead of that this technical solution presents possibility to change over to a "single computer policy".

Pullinen, M-J. (2012). Kriittisten tietojärjestelmien suojaaminen kyberuhilta (Protection of Critical Information Systems against Cyber Attacks). Master Thesis. Theseus. Espoo: Laurea (in Finnish).

Abstract: Critical infrastructure is nowadays more and more dependent on information systems. This thesis introduces cyber-attacks which have had impact on critical information systems around the world. By describing Finnish legislation and key actors on the field of information security, one can make conclusions about Finnish national capabilities to defend our critical Information systems. Cyber warfare capabilities of some nations which are strongly investing in the cyber domain are also shortly described. Most common attack and defence methods are introduced along with those methods that can especially pose a threat to critical information systems. Recommendations to improve protection of critical systems are created based on the work done during composition of the thesis. The recommendations include the necessity to define which systems are critical. Furthermore, creating information security auditing criteria focusing on critical systems is suggested. The criteria should not only be based on the security classification of the data processed on the system. The effects that system malfunction or interruption of services would cause should be also considered.

Design Science is used as a research approach in the thesis. Design science is used for creating something new. The thesis introduces a model that can be used as an extra tool to protect critical systems. A new artefact is created based on Hevners seven guidelines. The model can be developed further to an application. Model includes a threat analysis of state and nonstate actors. The model also includes an operational picture of the statuses of critical information systems.

Information Security of national Critical Information Systems can be significantly improved with this new defence model. The thesis highlights the growing meaning of information warfare alongside traditional warfare.

5.5 Tracking Services

The SATERISK project started to study satellite-based tracking services (Rajamäki, Pirinen, & Knuuttila, 2012). The MOBI project has continued to study these aspects of tracking that are related to ERVs. Rajamäki and Kämppi (2013) present a system-level description for the satellite-based tracking system for emergency management. The study of Rajamäki, Rathod and Kämppi (2013a) continues this task.

Rajamäki, J. & Kämppi, P. (2013). Secure and Reliable Satellite-based Tracking System for Emergency Management. In Proc. the International Congress on Engineering and Information (2013 ICEAI) January 25-27, Taipei, Taiwan.

Abstract: A Geographic information system (GIS) offers great deal of assistance in emergency management. Satellite-based tracking has long been considered a technology that compliments GIS operations. However, current satellite-based tracking systems have serious technical flaws and vulnerabilities. This paper presents a detailed modular system-level description for the satellite-based tracking system including control, space, tracking, communication, data processing, end-user and external applications segments. The paper further discusses and suggests how the technical vulnerabilities of satellite based tracking systems could be avoided taken in e.g. a hybrid tracking segment and multichannel communication paths.

Rajamäki, J., Rathod, P. & Kämppi, P. (2013a). A New Redundant Tracking System for Emergency Response. European Intelligence and Security Informatics Conference. August 12.-14.2013 Uppsala, Sweden.

Abstract: Geographic information systems (GIS) and global navigation satellite systems (GNSS) have transformed emergencies and disasters response across the world. These technologies are enabling emergency management agencies to carry out their duty efficiently. However, current GNSS-based tracking systems have serious technical flaws and vulnerabilities. This paper presents a modular system-level description for a hybrid tracking system. The paper further discusses and suggests how the technical vulnerabilities of GNSS-based tracking systems can be resolve.

5.6 Unmanned Aerial Vehicles

When looking at future common services for PPDR actors, unmanned patrol systems, such as unmanned aerial vehicles (UAV), employ high-tech devices. For example, the border between Russia and southern Finland has many twists and turns. Small UAVs and micro air vehicles (MAV) could be posted at intervals and launched either automatically to check abnormalities detected by static surveillance sensors or by duty officers at command posts

(Ruoslahti, Guinness & Viitanen, 2010). The United States uses a full-scale military UAV MQ9 Predator B to monitor its borders; however there are limits to their intended use (Waterman, 2007). According to Bolkcom (2005), UAVs are likely to be fielded as part of a larger system of border surveillance, not as a solution in themselves. MAVs launched from command posts along hard-to-access borders could provide low-cost, rapid-response imagery and other data in response to suspected border incidents (Ruoslahti et al., 2010). A new ERV should be able to act as a mobile field command and control station. Future field command system standards should take into account the control of UAVs/MAVs.

Project manager Ilkka Tikanmäki's Master's thesis, "Possibilities to Operational Use of Remotely Piloted Aircrafts in Finland", investigates how unmanned aircraft systems (UASs) can be used by authorities. Traditionally, the unmanned aircraft systems have been used in military applications. Recently, UAS applications for civilian purposes have increased significantly. Mr. Tikanmäki studies how to improve situational awareness and a real-time picture for operational use. He further explores the challenges of strategic management in public organizations, what kind of UAS services authorities will need, and what are currently the biggest obstacles to improve these services are also represented.

In addition, this section presents other research studies addressing the problem related to ICT systems and common services. The set of research work is presented below.

Tikanmäki, I. (2011). Possibilities to Operational Use of Remotely Piloted Aircrafts in Finland. Master Thesis. Theseus. Espoo: Laurea.

Abstract: This thesis consists of five international scientific publications as well as this summary, which brings together those publications. This thesis converses on improving situational awareness and real-time picture, challenges of strategic management in public organizations in above mentioned situations. Importance of networking for co-operating is also discussed. Legislation aspects in the provision of designing new applications and services in the field of Remotely Piloted Aircraft (RPA) and objectives to make a service innovation with RPA systems is one of the outputs of this thesis.

Scientific and technological developments in mobile communications, sensors, drive systems and other areas are rapidly making possible to develop UAVs with advanced technology. There has seen rapid growth in UAS industry during last years. That has happen not least because of civilian applications are growing. However, the limits of regulations and technologies restrict to allow 'file-and-fly' permissions equally for unmanned as for manned aircrafts. The objective of this thesis is to research what benefit is achieved by UAS services.

UAS classification process is ongoing in Europe and it's not completed. European authorities use unmanned aircraft's classifying into two categories: UA with the maximum take-off mass of more than 150 kg, regulated by EASA and UA with a maximum take-off mass less than 150 kg, regulated by the national civil aviation authority. When discussing about situational awareness and real time picture, we

should remember that many parties need these issues when they are working. Especially decision makers and their assistants need to know what is happening in the field.

The importance of cooperation between authorities has discovered an important subject to be developed. Close cooperation between the authorities achieves synergies between overlap functions by cutting and support functions to enable efficient use of. The biggest challenge in using Unmanned Aircraft Vehicles (UAVs) is that legislation doesn't recognise enough UAV as an aircraft. Training and other requirements for the operator and the actual flyer aren't specified for UAS-operations. UAVs development is waiting for standardization. The aim of this research is to analyze and assemble summary about this issue. From the research perspective there are needs for UAS and also social general ignorance how UAS can be exploit in civilian use. Challenge for cooperation in this particular case is to reconcile the needs of different actors - public and private - under common interests. UAS would significantly increase the number of the biggest priorities of safety, security and environmental issues.

Tikanmäki, I., Tuohimaa, T. & Rajamäki, J. (2011). How and why Unmanned Aircraft Vehicles can improve Real-time awareness? International Journal of Circuits, Systems and Signal Processing, Issue 5, Volume 5, 469-477.

Abstract: Unmanned Aerial Vehicles (UAV) have been used for a long time to improve situational awareness for many parties. During last 30 years UAVs role has received more attention and interest in global perspective. There are many reasons how and why this has occurred. This paper highlights those issues; why this matter is important and considerable. When discussing about situational awareness and real time picture, we should remember that many parties need these issues when they are working. Especially decision makers and their assistants need to know what is happening in the field. For that reason, it is noteworthy to focus on one of the most important way how to accelerate making of situational awareness and real-time picture. This is one of the components how to do it and why we need it.

Tuohimaa, T., Tikanmäki, I. & Rajamäki, J. (2011). Cooperation challenges to public safety organizations on the use of unmanned aircraft systems (UAS). International Journal of Systems Applications, Engineering & Development, Issue 5, Volume 5, 610-617.

Abstract: This study deals with the importance of networking for co-operating authorities and their duties. As an example, we will dissect unmanned aircraft system (UAS) utilization for improving and speeding up a situational awareness and a real-time picture. Networking is emphasized between cooperation with

national authorities, because the players are under the supervision of different ministries. Inter-ministerial co-operation is already in a good shape, but given the relevant persons in the mutual interaction may be scarce. In this point of view, the challenge for UASs use include ministries fragmented budgets, a lack of common practices of the new system of exploitation and the lack of cultural activities. It has revealed a need for networking between the authorities in cooperation of implementation of UAS. Different levels of networking means to cooperation between organizations: performing a similar task teams to cooperate, or individual experts formed a collaborative network. UAS cooperation with the authorities will act in all of the above (sectored, regional, level) mention areas.

The importance of cooperation between authorities has discovered an important subject to be developed. The Finnish Government's Security and Defense Policy states that the close cooperation between the authorities achieves synergies between overlap functions by cutting and support functions to enable efficient use of. Situational awareness and government collaboration will be developed both nationally and internationally. Efficient use of resources in society is a sensible, economical and appropriate. Therefore, in UAS development activities, must participate many part-sides (Police, Fire and Rescue Services, Border Guard, Customs, etc.). Strategy work requires a new perspective and you must be able to see large complexes. Different entities interact with each other and strategic decisions require courage. Successful organizations create a successful strategy, implement it and they are able to renew their strategies with the latest requirements.

References

- Bolkcom, C. (2005) Homeland security: unmanned aerial vehicles and border surveillance", CRS Report for Congress, 2005. [Online] Available: <http://epic.org/privacy/surveillance/spotlight/0805/rscb>.
- Hult, T. (2012). Turvallisuus- ja pelastusviranomaisten ICT-järjestelmien kehittäminen ja integraatio. (Public Protection and Disaster Relief services ICT-systems developing and integration) Thesis. Theseus. Espoo: Laurea (in Finnish).
- Lehto, J. (2012). Pelastustoiminnan parantaminen katvealueella sekä pilvipalveluiden hyödyntäminen pelastustoiminnassa: suunnittelututkimus. (Improving the rescue work at the shadow region and how the cloud computing can be used to improve the rescue work: design research in information systems) Master Thesis. Theseus. Espoo: Laurea (in Finnish).
- Lehto, J., Rajamäki, J. & Rathod, P. (2012a). Conceptualised View on Can Cloud Computing Improve the Rescue Services in Finland? Proceeding of the 11th WSEAS international conference on Applied Computer and Applied Computational Science, April 18.-20, Rovaniemi, Finland.

Lehto, J., Rajamäki, J. & Rathod, P. (2012b). Cloud Computing with SOA Approach as Part of the disaster Recovery and Response in Finland. *International Journal of Computers and Communications*, Issue 3, Volume 6, 175-182.

Ofem, P. (2011). Investigating the Role of Service Oriented Architecture as an Enabler of ICT Integration and Optimization in Public Protection and Disaster Relief Services - A Case Study of Medical Emergency Services in Finland. Master thesis. University of West of Scotland.

Ofem, P. & Rajamäki, J. (2014) Service oriented architecture as an enabler of ICT integration and optimization in public protection and disaster relief services: case study of medical emergency services in Finland, *International Journal of Computers and Communications*. [In Press]

Penttinen, J. (2013). Eri tietoturvaluokan palveluympäristöjen käyttö samalla päätelaitteella. (How to use different security level IT service environments using the same data terminal equipment) Master thesis. Theseus. Espoo: Laurea (in Finnish).

Pullinen, M-J. (2012). Kriittisten tietojärjestelmien suojaaminen kyberuhilta (Protection of Critical Information Systems against Cyber Attacks). Master Thesis. Theseus. Espoo: Laurea (in Finnish).

Rajamäki, J., Hult, T. & Ofem, P. (2011). ICT integration of public protection and disaster relief: services for fire and rescue personnel, *International Journal of Computers and Communications*, Issue 3, Volume 5, 2011.

Rajamäki, J., Pirinen, R. & Knuuttila, J. (Eds.). (2012). *SATERISK - risks of satellite-based tracking: Sample of evidence series*. Vantaa: Laurea-University of Applied Sciences, Leppävaara Unit.

Rajamäki, J. & Rathod, P. (2013). Service Standardization with utility computing and service oriented architecture as a tool for public protection and disaster relief. *Proceeding of the EISIC 2013 Conference Poster Session*. August 12, Uppsala, Sweden.

Rajamäki, J., Timonen, T., Nevalainen, J., Uusipaavalniemi, H., Töyrylä, T. & Arte, E. (2014). Human-machine interactions in future police vehicles: Applying Speech User Interface and RFID Technology, *International Journal of Systems Applications, Engineering & Development*, Volume 8.

Rajamäki, J. & Villemson, T. (2009a). Designing emergency vehicle ICT integration solution, in *proceedings 3rd International Conference on Communications and Information Technology*, 29-31 December, Athens, Greece.

Rajamäki, J. & Villemson, T. (2009b). Creating a service oriented architectural model for emergency vehicles. *International Journal of Communications*, Issue 2, Volume 3, 44-53.

Rajamäki, J. & Vuorinen, M. (2013). Multi-Supplier Integration Management for Public Protection and Disaster Relief (PPDR) Organizations, in Proceedings of the 27th International Conference on Information Networking (ICOIN), January 27-31, Bangkok, Thailand.

Ruoslahti, H., Guinness, R. & Viitanen, J. (2010) Airborne Security Information Acquisition Using Micro Air Vehicles: Helping Public Safety Professionals Build Real-Time Situational Awareness, HICSS.

Sihvonen, H-M. (2012). Studies on Software Process Improvement in Organizational Changes. Doctoral Thesis, Publications of the University of Eastern Finland, Dissertations in Forestry and Natural Sciences No 72.

Tikanmäki, I. (2011). Possibilities to Operational Use of Remotely Piloted Aircrafts in Finland. Master Thesis. Theseus. Espoo: Laurea.

Tikanmäki, I., Tuohimaa, T. & Rajamäki, J. (2011). How and why Unmanned Aircraft Vehicles can improve Real-time awareness? International Journal of Circuits, Systems and Signal Processing, Issue 5, Volume 5, 469-477.

Tuohimaa, T., Tikanmäki, I. & Rajamäki, J. (2011). Cooperation challenges to public safety organizations on the use of unmanned aircraft systems (UAS). International Journal of Systems Applications, Engineering & Development, Issue 5, Volume 5, 610-617.

Vilpas, M. (2012). Javan soveltuvuus DSiP-reititysjärjestelmän asetusmuokkaimen luontiin. (The suitability of Java in the creation of a DSiP routing system configuration editor) Thesis. Theseus. Espoo: Laurea (in Finnish).

Waterman, S. (2007). UAV tested For US border security, Washington, UPI, 12.2.2007. [Online] Available: http://www.spacewar.com/reports/UAV_Tested_For_US_Border_Security_999.html.

6 Actor-specific Services

Ilkka Tikanmäki, Pasi Kämppi & Paresh Rathod

With regard to actor-specific services, the MOBI project has researched different needs of specific PPDR actors. By ‘actor-specific services’, we mean those digital services that differ substantially from other PPDR responders needs. The common HMI for most of these actor-specific digital services should be the KEJO field-command system, and the digital services will run on top of common services via a standardized interface. This chapter presents the most essential applications for each actor group: law enforcement, emergency medical services, and fire and rescue services.

6.1 Law Enforcement Services

Law enforcement authorities ought to have forensics technology for investigations and field work. These kinds of technologies include advanced tracking systems that apply the Global Positioning System (GPS) to track criminals and vehicles that have been tagged. This allows LEAs to keep track of suspicious activity that can help solve cases. The Laurea University of Applied Sciences has widely studied these kinds of services within its SATERISK research project (Rajamäki, Pirinen, & Knuuttila, 2012).

In his article, Rajamäki (2013) studies new mobile digital services for border protection. Law enforcement authorities are using more and more technical surveillance equipment. Rajamäki et al. (2012) deals with the social acceptance of the use of these new methods. Rajamäki and Knuuttila (2013) concentrates on how investigation data can also be used as digital evidence in judicial courts. Rajamäki (2014) also studies cross-border information exchange procedures and technologies between law enforcement authorities of different countries. Jutila (2011) researches how to use fingerprint identification in police patrol cars. All these studies have an impact on the ICT systems used in LEA vehicles.

Rajamäki, J. (2013). *Mobile digital services for border protection: Standardization of emergency response vehicles. In Proceedings of the 2013 European Intelligence and Security Informatics Conference, pp. 256-261, IEEE Computer Society Conference Publishing Services (CPS).*

Abstract: Law enforcement authorities (LEA), such as border guards, suffer from intensive human involvement. Due to the economic situation, the main need of LEAs is to maintain their core services with significantly reduced budgets.

According to our multi methodical development research, the only realizable solution is the better piggybacking of information and communications technology (ICT) and digital services. This also means in field operations and thus in emergency response vehicles (ERV), ICT applications and digital services play a more and more important role. This paper presents a new layered approach for standardizing the electrical, electronic and ICT devices of ERVs. Thus on the basis of this infrastructure, the mobile digital services needed for public safety responders could be supplied.

Rajamäki, J., Tervahaltiala, J., Tervola, S., Johansson, S., Ovaska, I. & Rathod, P. (2012). How Transparency Improves the Control of Law Enforcement Authorities' Activities? IEEE Computer Society Conference Publishing Services (CPS), Washington DC, USA.

Abstract: When preventing and investigating crime the law enforcement authorities (LEAs) perform a variety of activities that affect civilians' privacy. Video surveillance, audio surveillance, technical monitoring and tracking are few to mention amongst many other activities. On various incidents, law enforcement is seeking more control rights that increases concern amongst citizens and also level of open debate increases steeply. The aim of this paper is to provide an improved understanding why transparency is a crucial factor succeeding in LEAs' technical surveillance. This research work also presents examples of current technological possibilities to create transparent and plausible monitoring for surveillance activities. The paper is based on the results and lessons learned from the Finnish SATERISK (SATEllite-based tracking RISks) research project executed during 2008-2011. Trusts in LEAs have always been high in Finland. Even though number of people in society who do not have any confidence in authorities, especially for police forces and their extended control. However, there are empirical and factual evidences that civilians are willing to give extended rights to authorities if used in intrusive means for extremely necessary situation. In such cases, people are more open and expecting authentic timely information. The research work also discusses the challenges faced by LEAs during criminal investigations.

Rajamäki, J. & Knuuttila, J. (2013). Law Enforcement Authorities' Legal Digital Evidence Gathering Legal, Integrity and Chain-on-custody Requirement. European Intelligence and Security Informatics Conference. August 12.-14.2013 Uppsala, Sweden.

Abstract: When carrying out criminal investigations, Law Enforcement Agencies (LEAs) apply new technology in very effective ways. However at worst, LEAs must perform many stages twice with the help of different technical tools. When investigating the identity of criminals LEAs may apply totally different technical tools than when gathering evidences for charge, because the data provided by

investigating may not be valid in court. For that reason, a new monitoring system that goes beyond state of the art is needed. Three organizational layers need attentions: 1) LEA; the people that actually retrieve and store the information. 2) Prosecutors and their offices; how they get access to the information. 3) Courts; the final destination of the retrieved information. Until now, the information gathering tools for LEAs have been engineered focusing only on the best way to retrieve the information from the target. The attention paid to the legal, integrity and chain-of-custody requirements as well as social acceptance and legal oversight in connection with retrieving information has been inadequate and guidance on the matters has existed only in manuals written by legal departments.

Rajamäki, J. (2014). Cross-border Information Exchange between Law Enforcement Authorities. Proceedings of the 8th International Conference on Communications and Information Technology (CIT '14), Tenerife, Spain, January 10-12, 2014, pp. 205-210.

Abstract: The nature of crime has internationalized. Therefore the transmitting of tracking and other status information between Law Enforcement Authorities should become an everyday business. The goal of this paper is to present a solution for international cooperation between law enforcement authorities. The proposed solution is based on Public Key Infrastructure operation model built for the financial sector companies.

Jutila, T. (2011). Sormenjälkitunnistus poliisin kenttäolosuhteissa (Fingerprint identification in police field duty). Thesis. Theseus. Espoo: Laurea.

At the present time the methods of biometric identification are more important than ever before and for many reasons. ID cards and PIN codes are not always enough to provide security and different kinds of biometric identification methods are also needed. One of the oldest and most reliable forms of identifying people is through fingerprint identification. Most commonly this type of identification is used to control persons' access to certain places, but it is more commonly used to solve crimes.

This study examines the possibility of placing a fingerprint identification device in a police car, and considers the advantages and disadvantages of such a proposal.

Three policemen were interviewed for the study, all of whom work in criminal investigation and use fingerprint identification in their work. Conclusions were drawn based on the opinions of the interviewees, theories regarding the fingerprint identification process and Finnish laws concerning individual privacy.

The study also considered ICT solutions in a police vehicle and the vehicle resources of the police forces in Finland.

Policemen considered that the priorities of the system should be reliability and the speed of the actual identification process. At the present moment the difficulties of implementation of such system is challenging. The current state in which the fingerprint identification is at police stations cannot be placed in the police vehicle as it is. The main reason is great demands of bandwidth. Additionally the multiplicity of different ICT solutions poses many difficulties.

The result of the thesis is a compromise in which the suspect fingerprints are stored in a medium in a police vehicle. This makes it possible to later review them in a better equipped police station where there is a broadband connection to AFIS-database.

6.2 Emergency Medical Services

Medical information systems and databases have developed rapidly in recent years. Progress in mobile technologies has generated a demand to take these functionalities into account in mobile work in ambulances. The ambition to make the most out of the medical information systems in these mobile environments is to take advantage of the capabilities in mobile technologies to make use of the systems remotely. The primary functions for these mobile technologies and systems are to substitute the paperwork, provide an interface to search for information, and to enter information into the medical information systems while on a mobile emergency. Benefits that will be gained from real-time patient information updates are the increased quality of care and more accurate information about the patient's condition during the mobile emergency care.

Ofem, P. & Rajamäki, J. (2014). Service Oriented Architecture: An Enabler of ICT Integration and Optimization in Public Protection and Disaster Relief Services. Proceedings of the 8th International Conference on Communications and Information Technology (CIT '14), Tenerife, Spain, January 10-12, 2014, pp. 346-359.

Abstract: There is a known global initiative to improve health care services using service oriented architecture (SOA) and Web Services. The decision support systems so far introduced have been based on software development approaches and architectural philosophies of which inherent limitations do not adequately tackle the growing pressure on the health care services such as the emergency services and the integration of systems that support such services. These systems are to a large extent not interoperable and do not support agility, reusability and integration owing to the approaches that gave birth to them. Since health services are moving towards the adoption of SOA and Web Services, the research proposes a SOA model for use in medical emergency vehicles and their control centres together with a conceptual innovative service blue print for the domain. Issues affecting

implementation of SOA were also addressed. The idea is to address issues of ICT integration, interoperability and support for information inter-change within the domain. The research findings suggest that, a SOA solution is feasible in the problem domain and standards-based interoperability and integration can be achieved. Issues affecting implementation of SOA were also addressed.

6.3 Fire and Rescue Services

When a fire rescue unit gets an alarm and they need to get to the location of the emergency, they will get all the information and emergency details through different kinds of systems. Currently, there are many different field management systems in use in Finland; these include Vaahtotykki, Merlot, Merlot Mobile and PEKE. Vaahtotykki is a communications system and aiding system used in managing take-offs and fire brigade alarms. It was developed by Special Code Oy. The system displays updated information about an ongoing fire rescue emergency and the personnel involved in handling the situation. Even more, the system can provide estimations of arrival times for different emergency units, and it also records information on skills and certifications of different personnel involved in the emergency situation, thus enabling an efficient management of resources. Merlot, created by Logica, is a diverse field command system that combines multiple techniques into one; that is, job dispatching, radio terminals, Internet and positioning are all managed through this one system. Merlot Mobile is the same system put into a mobile operating environment. It communicates with the Merlot main system interface and creates an effective inter-communication network in the field of operations. PEKE is a field command system for emergency vehicles. It has been refined and built over the Finnish police field management system POKE, and therefore it is a well-known and highly developed system. PEKE is a combined system that can be used both on fixed positions (command centre) and mobile environments (emergency vehicles). Some key features are: receiving tasks from the emergency centre, sending and receiving statuses of owned vehicles and other vehicles, messaging and navigating.

All field management systems have been designed for a specific purpose with specific needs, but they should have been designed more efficiently to work together with other systems. At the moment, personnel need to use multiple systems to deliver or gather information from ongoing situations. Using multiple systems means many different functions and steps to send or receive important data. It is also time-consuming and makes customer service less efficient. Combining these functions under one system or control panel would also improve the interoperability between rescue units and other PPDR actors.

References

Husso, J. (2013). Autonominen videokuvan siirtoon soveltuva tietoverkkoratkaisu viranomaisajoneuvoihin (Autonomous video transmission network for government vehicles). Thesis. Theseus. Espoo: Metropolia (in Finnish).

Jutila, T. (2011). Sormenjälkitunnistus poliisin kenttäolosuhteissa (Fingerprint identification in police field duty). Thesis. Theseus. Espoo: Laurea (in Finnish).

Ofem, P. & Rajamäki, J. 2014. "Service Oriented Architecture: An Enabler of ICT Integration and Optimization in Public Protection and Disaster Relief Services," Proceedings of the 8th International Conference on Communications and Information Technology (CIT '14), Tenerife, Spain, January 10-12, 2014, pp. 346-359.

Rajamäki, J. (2013). Mobile digital services for border protection: Standardization of emergency response vehicles. In Proceedings of the 2013 European Intelligence and Security Informatics Conference, pp. 256-261, IEEE Computer Society Conference Publishing Services (CPS).

Rajamäki, J. (2014). Cross-border Information Exchange between Law Enforcement Authorities. Proceedings of the 8th International Conference on Communications and Information Technology (CIT '14), Tenerife, Spain, January 10-12, 2014, pp. 205-210.

Rajamäki, J. & Knuuttila, J. (2013). Law Enforcement Authorities' Legal Digital Evidence Gathering Legal, Integrity and Chain-on-custody Requirement. European Intelligence and Security Informatics Conference. August 12.-14.2013 Uppsala, Sweden.

Rajamäki, J. & Kämppi, P. (2013). Secure and Reliable Satellite-based Tracking System for Emergency Management. In Proc. the International Congress on Engineering and Information (2013 ICEAI) January 25-27, Taipei, Taiwan.

Rajamäki, J., Pirinen, R. & Knuuttila, J. (Eds.). (2012). SATERISK - risks of satellite-based tracking: Sample of evidence series. Vantaa: Laurea-University of Applied Sciences, Leppävaara Unit.

Rajamäki, J., Rathod, P. & Kämppi, P. (2013a). A New Redundant Tracking System for Emergency Response. European Intelligence and Security Informatics Conference. August 12.-14.2013 Uppsala, Sweden.

Rajamäki, J., Rathod, P. & Kämppi, P. (2013b). Hybrid Multi-Channel and Redundant Tracking System in Emergency Response. In Recent Advances in Computer Engineering Series, vol. 16: Proceedings of the 2nd International Conference on Information Technology and Computer Networks (ITCN '13), pp. 177-182.

Rajamäki, J., Tervahaltiala, J., Tervola, S., Johansson, S., Ovaska, L. & Rathod, P., (2012). How Transparency Improves the Control of Law Enforcement Authorities' Activities? IEEE Computer Society Conference Publishing Services (CPS), Washington DC, USA.

7 Demonstrations

Paresh Rathod, Pasi Kämppi & Ilkka Tikanmäki

This chapter briefly presents some of the piloting work done in the MOBI project. The target of Work Package 8 (WP8) was to build a demo vehicle with field-proven technology. That also includes generating new products and services using innovations and research done during the project period. This piloting work is done by researchers and students with project partners. The Finnish National Police Board and the Police Technical Centre agreed to co-operate in equipping the vehicle, and they provided a real van-sized police patrol vehicle as a platform for the pilot field study, experiment and testing with real users.

7.1 Introduction

The van is located and parked at the Laurea Leppävaara unit under supervision project managers Ilkka Tikanmäki and Pasi Kämppi. Both researchers also cooperated with industrial partners. Industrial partners provided the needed technology and technical support for the installations, testing and experimenting with new innovations. The project managers, researchers, lecturers and students integrated all together as a seamless system. Project manager Pasi Kämppi has been actively involved in piloting a demo vehicle and also acted as a principle engineer.

The first section describes the vehicle platform for testing and demonstrations. The second section includes information about ICT systems in a vehicle, including an onboard computer, voice communications and data communications. A new smart battery system is presented in the third section, and the last section describes an RFID-based equipment inventory solution. Over all, this chapter is a more visual demonstration of the project outcome.

7.2 Vehicle Description: Platform for Field Testing and Demonstrations

The National Police Board and the Police Technical Centre provided a van-sized police patrol vehicle for the MOBI project as a testing and demonstration platform. A third-party company retrofitted the vehicle as a police patrol vehicle, and the vehicle had all needed retrofits specified by the Finnish police technical centre. The vehicle was located at the

premises of the Laurea University of Applied Sciences, and the Laurea UAS project managers coordinated the vehicle-building process.

The van-sized patrol vehicle is based on a Volkswagen Transporter T5 vehicle. The following is a list of some of the specifications. The vehicle has four-wheel drive (SUV), a diesel engine, a more powerful alternator and a manual gearbox. A third-party company has installed a plastic rooftop with integrated alarm lights. The roof-top modification also provides a higher interior ceiling and needed space for antennas, cables and telecommunication equipment. The electric supply system has a major upgrade in the pilot vehicle; there was need for an additional battery for the ICT system and equipment, a control system for alarm lights and sirens, an intelligent equipment management system with the ability to disable low priority equipment in case of low battery voltage, an internal battery charger for external power feed, and an integrated 230V inverter (Rajamäki, 2013).

The interior space is divided into three sections: cabin, office space and transport space. Generally they are categorized as described below.



(1) Vehicle Control Space



(2) Mobile Office Space



(3) Transport Space

The cabin has minor modifications, including an additional secure locker storage console and space for additional equipment. The office space has a bench with secure locker storage space, a desk for paperwork plus extra storage space integrated in the rooftop. The transport space is a combination of a jail and storage space (Rajamäki, 2013; Rathod & Kämppi, 2013). Pictures 1-4 shows the vehicle platform that was used for testing and demonstration purposes.



Picture 1 Retrofitted Volkswagen Transporter T5.



Picture 2 Cabin



Picture 3 Office Space



Picture 4 Transport Space

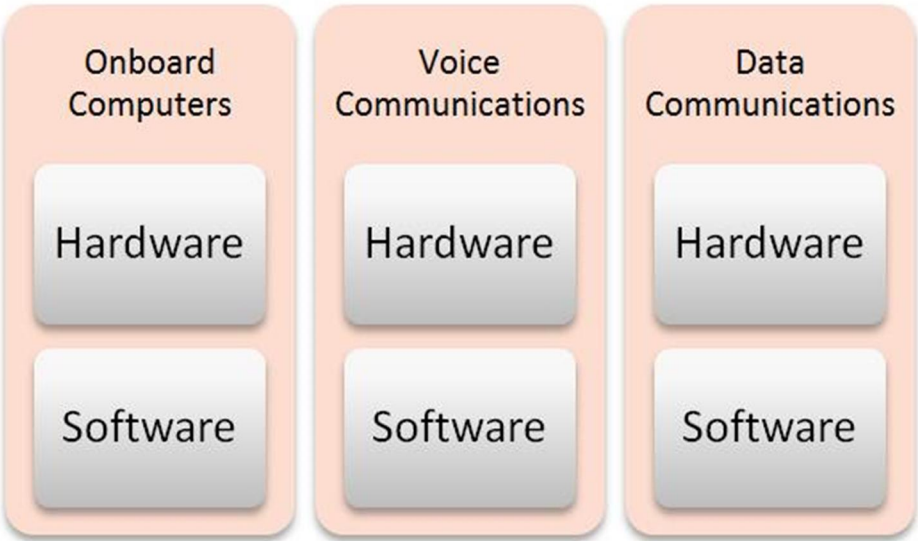
The users of vehicle emphasizes the requirements of ergonomic design, storage space, doors, windows, seats, free space, freeway, and considers the safety and security of persons onboard. Thoughtful cabinet placement and equipment storage enhances the safety, security and performance. Researchers and engineers have considered those recommendations with practical adjustments, graphically listed below.



7.3 Emergency Response Vehicles (ERVs) and Quality of Service (QoS)

The research study led by Dr Jyri Rajamäki recommends that vehicles' ICT systems can be simplified by dividing ICT architecture into a layered architecture that has standardized interfaces. Rajamäki recommends that ICT solutions have to be robust, easy to install, with special attention paid to information security. In addition to very robust ICT systems for

communications systems, special attention is to office working space is required. This section describes and demonstrates the ICT systems that were installed during the MOBI project. The four main components were onboard computers, voice communications and data communications, graphically listed below (Rathod & Kämppi, 2013).



7.3.1 Onboard Computers

An onboard computer is the heart of the vehicle ICT system, and it offers a user interface for applications such as a field command system, a speed radar and an automatic vehicle recognition system. The onboard computer system consists of a main unit, touch screen displays (a 12-inch display in the cabin and a 10-inch display in the office space), a keyboard and a mouse. The MOBI project partner SUNIT provided all needed equipment. All equipment is presented in the following figures.



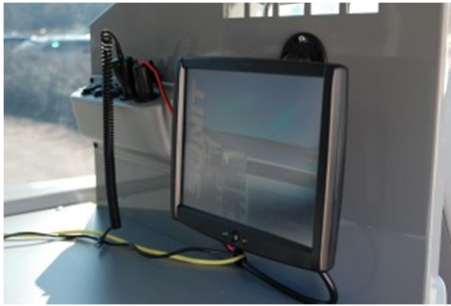
Picture 5 Cabin Touch Screen
– 12 inch



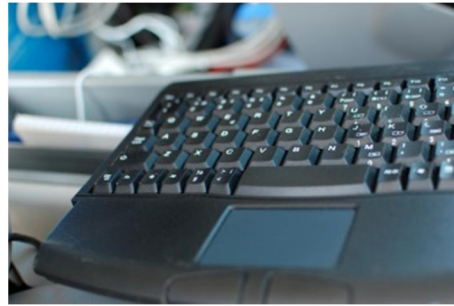
Picture 6 Main Unit



Picture 7 Touch Pad Mouse



Picture 8 Office Space Touch Screen – 10 inch



Picture 9 Keyboard

The following table describes the configuration of the onboard computers.

Onboard computers

SUNIT FD	CPU – Intel CORE Duo L7400 1,5 GHz Memory – 2048 MB
	OS – Windows XP (New Version Recommended)
Cabin Display	
SUNIT 12 Vehicle PC Display	12.1 inch TFT Resolution XGA 1024 x 768
Office Space Display	
SUNIT 10 Vehicle PC Display	10.4 inch TFT Resolution XGA 1024 x 768
Keyboard	
QWERTY standard	86-Key Standard Mini-AT Keyboard with Touchpad
Touch pad Mouse	
Special Mouse	Dust Resistant and Waterproof Mouse

7.3.2 Voice Communications

It is evident that Terrestrial Trunked Radio (TETRA) voice communication is an extremely important tool for PPDR operations, and every Finnish emergency vehicle is equipped with a TETRA vehicle radio. Our pilot study also had a Terrestrial Trunked Radio (TETRA) system for voice communications. The vehicle was equipped with one vehicle terminal and one handheld terminal. The Cassidian Finland TETRA test network offered radio coverage for field testing. Additionally, the vehicle terminal was integrated with an onboard computer for a graphical TETRA terminal user interface (Roisko, Kämppi & Luojus, 2013). Cassidian Finland provided all needed TETRA equipment. The following figures present the logical layout of the TETRA-based voice communication system and the physical and graphical user interface for the vehicle's TETRA radio.

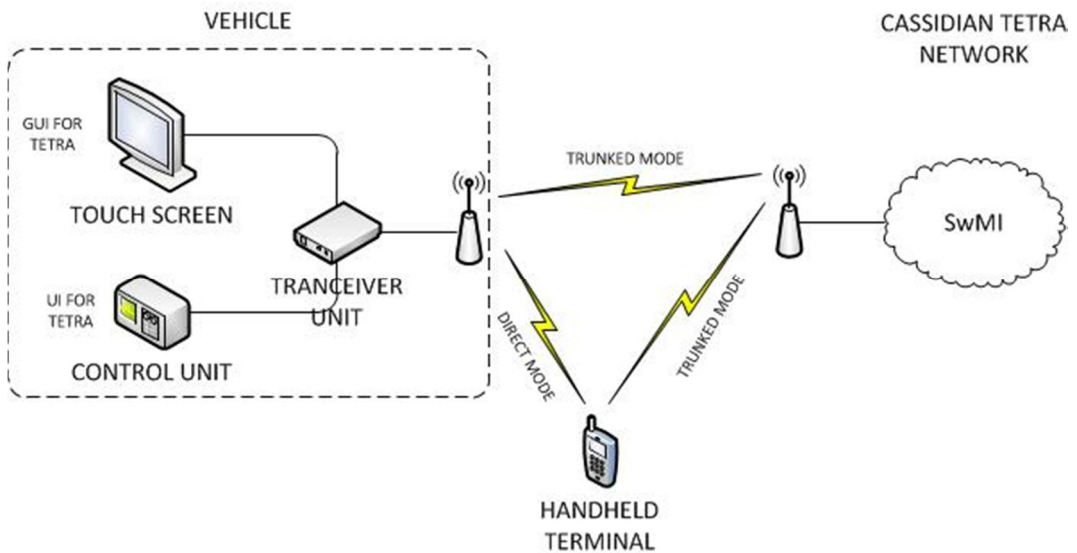


Figure 5 Logical layout of the TETRA-based voice communication system (Kämppe, 2014).

This field pilot study was conducted in three phases. In the first phase, theme interviews were conducted in order to understand the context and action models in the PPDR field operations. The second phase contained a heuristic evaluation for the touch screen based UI. In the heuristic evaluation, the UI was examined with the help of guidelines based on heuristics by Nielsen. In the third phase, usability tests were arranged. A usability test is a technique used to evaluate an application by testing it with a representative of the end-users. In the test, users try to complete defined tasks with the touch screen based UI while observers watch, listen and take notes.



Figure 6 Cassidian TMR 880i user interface (CUR-3) installed on the middle console. The radio transmitter is the inside of the console.



Figure 7 Screenshot of TETRA radio graphical user interface

There were certain software and hardware setups used to pilot the concept, as listed below.

Vehicle Terminal

Cassidian products

Cassidian TMR880i RC-9
Cassidian CUR-3 for physical user interface
prototype software for graphical user interface

Handheld Terminal

Cassidian Products

Cassidian THR880i RC-2

7.3.3 Data Communications

The data communication system was built on top of the DSiP-based communication architecture. DSiP-based communication architecture combines several wireless data bearers as a single channel for the user's point of view. (Holmström, Rajamäki & Hult, 2011). The system contained a vehicle laptop, vehicle onboard computer, HUB, vehicle DSiP wireless router, DSiP gateway, and an application server. Project partner Ajeco offered technology for the DSiP communication system. The experiments and research studies were already presented in previous chapters and hence this section focuses on reporting the pilot demonstration. However, it would be useful to understand the logical structure. The logical layout of the system is presented in the following figure.

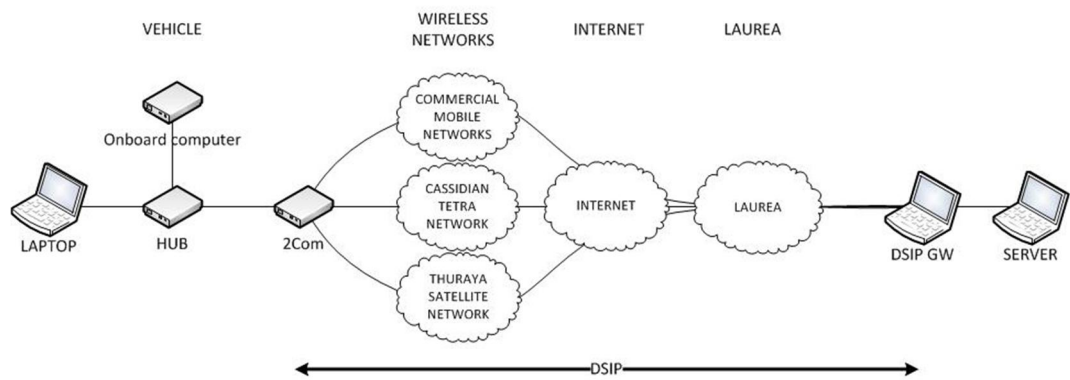


Figure 8 The logical layout of the DSiP-based communication system (Kämppi, 2014).

The demo installations included a wireless router, DSiP gateways, a satellite antenna, HUB and other hardware/software equipment. As earlier mentioned, the DSiP is entirely a software protocol solution. There are fundamentally two types of software elements in the solution: DSiP-routers and DSiP-nodes. The nodes constitute interface points (peers) to the DSiP routing solution, and the DSiP-routers drive traffic engineering and transport in the network. DSiP routers establish multiple authenticated and encrypted, sometimes parallel, connections according to configuration parameters, between each other, and the nodes establish multiple simultaneous connections to one or more routers in the system. All connections may be strongly encrypted and trustworthy, based upon the use of certificates, which effectively means that all elements in the DSiP routing solution are known.

The following figures show the installation of the wireless router, the setup for the DSiP gateway and the application server, installations of HUB, satellite modem and onboard computer and also presents the installation for an active satellite antenna.

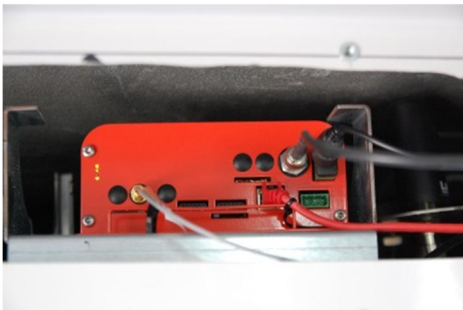


Figure 9 Ajeco Wireless Router



Figure 10 HUB, Satellite Modem and Onboard Computer setup

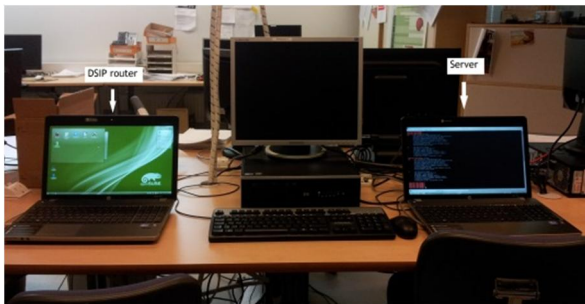


Figure 11 DSiP gateway (left) and Application server (right).



Figure 12 Thuraya Active Satellite antenna installed on the rooftop with magnets.

Following is list of used equipment and software in this demo setup.

Wireless router	Ajeco 2Com 2 x 2G/3G data modem, 1 x TETRA data modem
HUB	Zyxel GS-108B
Vehicle Laptop	HP ProBook 4530s Windows 7 Professional SP1
Onboard computer	Sunit fD Windows XP SPxx (New version recommended)
DSiP GW	HP ProBook 4530s Suse Linux Ajeco DSiP GW software
Application Server	HP ProBook 4530s Suse Linux FTP iPerf

7.4 Smart Batteries

Due to the wide range of electric and electronic equipment, the power consumption of a modern emergency vehicle is very high. Our experiment outcomes also verified and cross-checked while analyzing user interviews when defining the user requirements. Users indicated strongly that the battery goes down fast and the vehicle personnel have no means of getting information or any measures to check the actual ‘state of health’ of the battery. Our research study was focused on finding out: (1) a solution to improve battery capacity with a longer lifetime, (2) how to improve personnel awareness about the battery state, and (3) how to implement a solution in the emergency vehicle. We report our demo experiments here.

In the demo vehicle, the retrofitted vehicle has an additional battery under the driver's seat for ICT systems and other vital equipment. Laurea UAS, Metropolia UAS and Akkuvoima created a new smart battery solution with 28% better capacity, protection against 100% depth of discharge and real-time battery health state monitoring capability. Smart battery modules were integrated with the onboard computer that offered a computing platform for monitoring software (Kämppi & Rathod, 2013). Laurea UAS coordinated the project work, Metropolia UAS composed the monitoring software, and Akkuvoima provided smart battery modules and charger. The following figure presents the logical layout of the smart battery system.

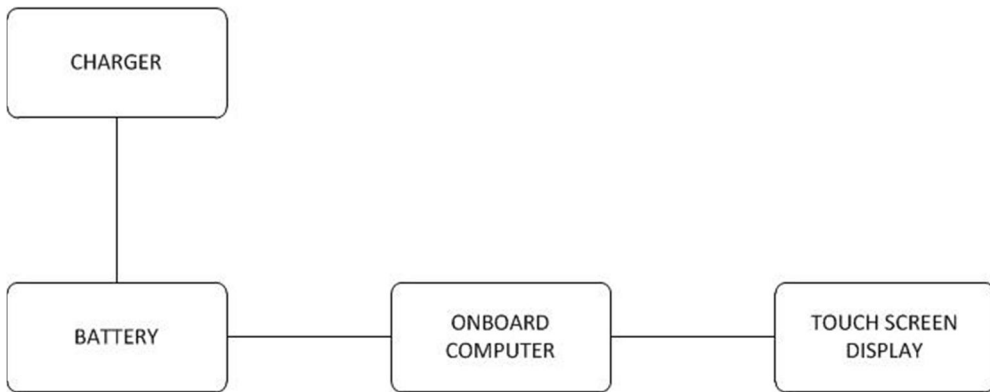


Figure 13 Logical layout for smart battery solution (Kämppi & Rathod, 2013)

As discussed earlier, the electrical power plays an extremely vital role in emergency vehicles; the vehicles are turning into mobile offices. To handle increasing power consumption, the vehicles are equipped with (A) a dedicated start-up battery, (B) a smart battery module for equipment, (C) an inverter/charger with the possibility of external charging, (D) a standby main unit for manual equipment control and intelligent power management, (E) a standby control panel/display, (F) an onboard computer, and (G) a touch screen display.

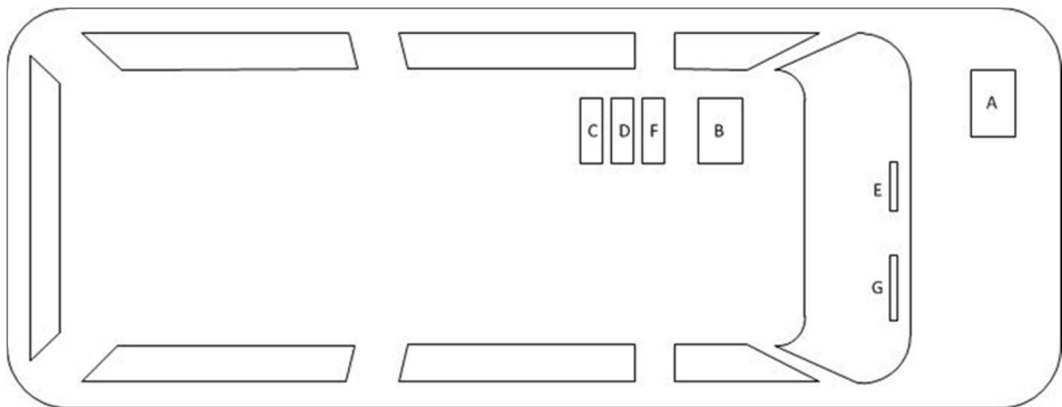


Figure 14 Components of the smart battery system (Kämppi & Rathod, 2014).

Figure 15 below presents a new battery module installation under the driver's bench. Figure 16 presents the new battery charger.



Figure 15 Smart battery modules installed below driver seat.



Figure 16 Battery charger

Following is list of used equipment and software in Smart Battery system.

Battery modules	3 x SAFT Smart VH Module RS-232 adapter for computer connection
Charger	Alfatronics AD 115/230-24
Onboard computer	SUNIT fD
Monitoring Software	Akkusofta v 1.0

Figure 17 shows a screenshot of the real-time battery health state monitoring software we call 'Smart Battery'.

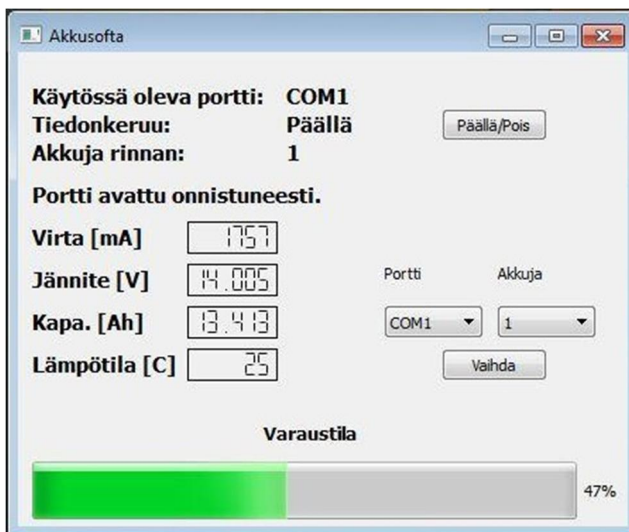


Figure 17 Screenshot of battery health state monitoring software. Software presents numerical output for battery current, voltage, capacity, temperature and state of charge.

7.5 Smart Inventory System (Based on RFID Technology)

There are several pieces of equipment in an emergency vehicle that cannot be humanly identified and verified to be on the board. Some of this equipment is crucial before, during, or after emergency operations. Users confirmed their concerns about equipment availability during their interviews. Our research study came up with technological solutions to the problem. We have used RFID technology to demonstrate an RFID-based equipment identification system in the van-sized police patrol vehicle. The following figure illustrates how RFID tags were placed during field testing.

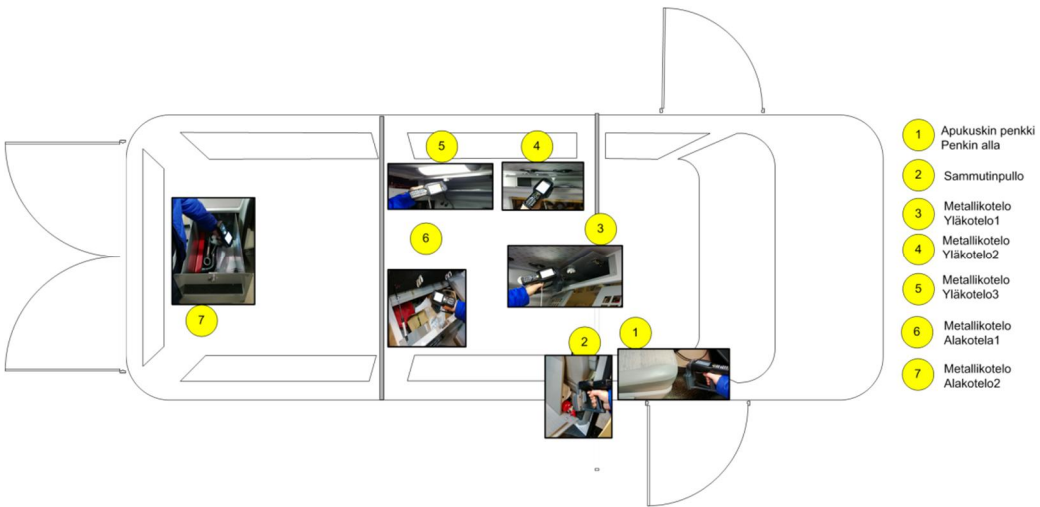


Figure 18 Visualization for RFID tag positions in field testing. (1) Under co-driver's seat. (2) Fire extinguisher. (3) Upper metallic storage box. (4) Upper metallic storage box. (5) Upper metallic storage box. (6) Lower storage box. (7) Lower metallic storage box (Timonen, 2013).

During the demo setup, we used a handheld RFID reader, soft RFID tags and hard RFID tags. Tags were placed in seven different positions, and the recognition performance was measured by a handheld RFID reader (Timonen, 2013). Nordic ID provided a handheld RFID reader, SmartRac provided soft RFID tags, and Confidex provided hard RFID tags. The following figures illustrate some of our demo setups.



Figure 19 Handheld RFID-reader



Figure 20 Soft RFID-tags that are suitable for non-metallic surfaces (Timonen, 2013).

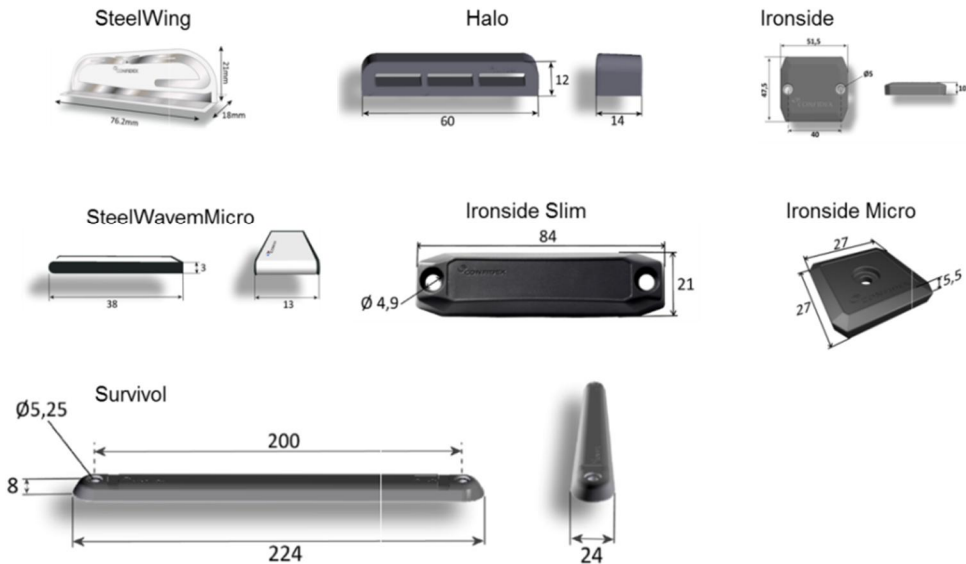


Figure 21 Used hard RFID-tags that are suitable both non-metallic and metallic surfaces (Timonen, 2013).

7.6 Conclusion

We have learned in previous chapters that the current emergency response vehicle (ERV) is an extremely complicated combination of different technologies and solutions to function and perform in varying conditions. The target of the MOBI project was to form common standards for designing emergency vehicles and also to describe ICT systems in use, investigate power consumption and create a demo vehicle with new innovations. This chapter has presented the demo vehicle systems and services concept that were piloted and field-tested during the project.

References

- Holmström, J., Rajamäki, J. & Hult, T. (2011). DSIP Distributed Systems intercommunication Protocol - A Traffic Engineering Solution for Secure Multichannel Communication. 10th WSEAS International Conference on Applications of Computer Engineering, March 24-26, 2011, Playa Meloneras, Gran Canaria, Canary Islands, Spain.
- Kämppi, P. & Rathod, P. (2013). Smart Battery System for Emergency Vehicles: Results from a Pilot Field Study. 2nd International Conference on Connected Vehicles & Expo. Las Vegas, Nevada, U.S.A. (In print).
- Rajamäki, J. (2012). Designing the Future Emergency Service Vehicle: Needs, Approach, Benefits and Competition. Nordic and Baltic Journal of Information and Communications Technologies [In review]. (Presented at the Conference of Next generation Public Safety and Emergency -Technologies, Policies and Business perspectives 10-11 December 2012, AAU Copenhagen, Denmark.)
- Rathod, P. & Kämppi, P. (2013). User Requirements of Emergency Response Vehicles: Preliminary Findings from a Current Research Study. 2nd International Conference on Connected Vehicles & Expo. Las Vegas, Nevada, U.S.A. (In print).
- Roisko, V., Kämppi P. & Luojus S. (2013). Touch Screen Based TETRA Vehicle Radio: Preliminary Results of Multi-methodology Usability Testing Prototype. 2nd International Conference on Connected Vehicles & Expo. Las Vegas, Nevada, U.S.A. (In print).
- Timonen, T. (2013). RFID-teknologian hyödyntäminen poliisin toimintavarmuuden varmistamiseksi: Case poliisipartio. (The utilization of RFID-technology in law enforcement: Case Police patrol). Master thesis. Theseus. Espoo: Laurea (in Finnish).

8 Commercialization and Dissemination

Jyri Rajamäki, Rauno Pirinen & Juha Knuuttila

8.1 NABC Analysis

8.1.1 NABC Framework

There are multiple ways that innovations can be created and commercialized. One model with a practical and structured framework for innovation work is the NABC (Need, Approach, Benefits and Competition) framework created by the Stanford Research Institute (SRI) (Carlson & Wilmot, 2006). The NABC framework highlights the market needs, solution approach, solution benefits and competition dimensions of any solution being created. The goal of every innovation is to create and deliver customer value that is clearly greater than the competition's. During a research and development project whose goal is an innovation, the iterative use of the NABC framework ensures that the R&D work concentrates on the right issues. The iterative use of the NABC framework shown in Figure 22 answers the following questions.

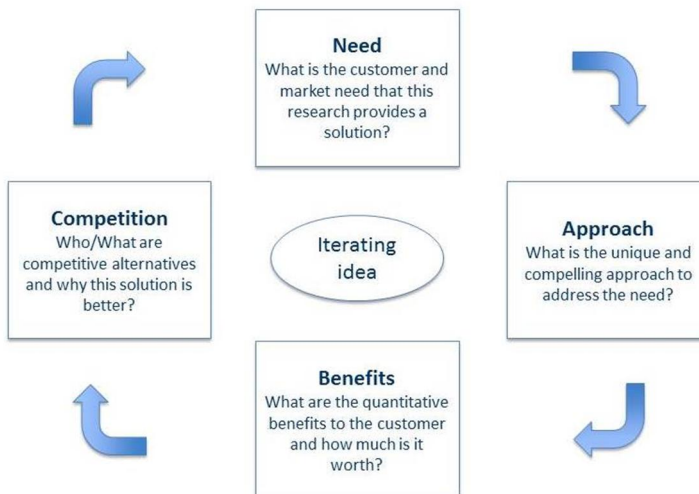


Figure 22 Iterative use of the NABC framework.

What are the important customer and market needs? A need should relate to an important and specific user-client segment or a well-identified market opportunity, with the market size and end-customers clearly stated (Carlson & Wilmot, 2006). What is the unique approach and compelling solution for addressing the specific client need? This should be drawn, simulated or made into a mock-up to help convey the vision required. As the approach develops through iterations, it becomes a full proposal or business plan, which can include market positioning, cost, staffing, partnering, deliverables, a timetable and intellectual property (IP) protection. If a product is being developed, it must also include product specifications, manufacturing, distribution and sales (Carlson & Wilmot, 2006).

What are the client benefits of our approach? Each approach to a client's needs results in unique client benefits, such as low cost, high performance or quick response. Success requires that the benefits be quantitative and substantially better, not just different. Why must we win? (Carlson & Wilmot, 2006). Why are our benefits significantly better than the competition's? Everyone has alternatives. We must be able to tell our client or partner why our solution represents the best value. To do this, we must clearly understand our competition and their value proposition and our client's alternatives (Carlson & Wilmot, 2006).

8.1.2 NABC Analysis of the MOBI Project

A new PPDR vehicle concept could be seen as an innovation. When categorizing research findings by bringing the NABC logic and presentation of value creation in the context of PPDR vehicles, the following observations could be made.

Needs: PPDR, along with other public sector organizations, are facing significant pressures to maintain core services with significantly reduced budgets. Traditionally, PPDR has a large number and range of emergency response vehicles. These are mostly normal production vehicles that have been retrofitted with a wide array of aftermarket equipment, according to their role. Today, PPDR responders have more and more ICT facilities and applications in their vehicles. The traditional approach of individually wiring each stand-alone system resulted in expensive and cumbersome wiring looms and connectors. Why can't the PPDR vehicles' ICT applications be simplified and rationalized to help PPDR responders' work more efficiently and effectively? Can two items of equipment be combined into one to make it easier to use and decrease power consumption?

Approach: ERVs' ICT systems should be divided into four layers: the vehicle infrastructure and power management layer, the communications layer, the service platform and common services layer, and the actor-specific services layer. The interfaces between the layers should be standardized. The communications layer and the service platform and common services layer could be identical for all ERVs, as the vehicle infrastructure and power management layer is dependent on the vehicle type (e.g. saloon car or van) and the actor-specific services layer is dependent on the PPDR actor (e.g. LEA or EMS).

Benefits: The benefits of the 'MOBI approach' to the development of ERVs are similar to those that the OSI model brought to the field of data communications. The layered approach breaks ERVs' electrical, electronic, information and communication technologies into smaller and simpler parts, as well as smaller and simpler components, thus aiding component development, design and troubleshooting. The standardized interfaces allow modular engineering, meaning that different types of hardware and software components communicate with each other. Interoperability between vendors allows multiple-vendor development through the standardization of ERV components. It defines the process for connecting two layers together, promoting interoperability between vendors. It allows vendors to compartmentalize their design efforts in order to fit a modular design that eases implementation and simplifies troubleshooting. The layered approach ensures the interoperability of technologies, preventing the changes in one layer from affecting other layers, allowing quicker development and accelerating evolution. It provides effective updates and improvements to individual components without affecting other components. All these aspects have already been found to be very valuable in the field of data communications after the OSI model has been applied. In particular, open standards ease the ability of SMEs coming into the business, which improves the supply of new public safety ICT products and decrease their prices. In addition to cost savings, the interoperability and availability of new public safety ICT services is improved.

Competition: Traditionally, good cooperation between different authorities in Finland enables development for the whole PPDR sector. The supportive atmosphere enables productive co-operation between universities, authorities and companies. Finland has evidences of success in developing ICT systems: development of public mobile networks, the first nationwide TETRA network, and the POKE field command system.

Rajamäki, J. (2012). Designing the Future Emergency Service Vehicle: Needs, Approach, Benefits and Competition. Nordic and Baltic Journal of Information and Communications Technologies [In review]. (Presented at the Conference of Next generation Public Safety and Emergency - Technologies, Policies and Business perspectives 10-11 December 2012, AAU Copenhagen, Denmark.)

Abstract: Public protection and disaster relief (PPDR) responders must manage on different emergency situations in land, water and air. Emergency response vehicles (ERVs) are specially equipped and on permanent standby for serious incident response. Modern ERVs are fully of electrical, electronic and ICT systems. However, there are possibilities of improvement in various aspects of ERVs. That will enhance performance, effectiveness and optimum usage of resources. The Finnish MOBI (Mobile Object Bus Interaction) research and development project aims to create a common international ICT infrastructure for all ERVs, based on better integration of ICT systems, applications and services. Another aim is to extend this project to other ERVs in European countries, permitting the standardisation of tools and technology in EU countries. One model that gives a practical and structured framework for innovation work is the NABC approach created by the Stanford Research Institute (SRI). NABC highlights the market needs, solution approach,

solution benefits and competition dimensions of any solution being created. Our approach is to divide ERVs' ICT systems into four layers (a vehicle infrastructure and power management layer, a communications layer, a service platform and common services layer, and an actor-specific services layer) between which have standardised interfaces. The benefit is that open standards ease especially small and medium enterprises coming to the business, which improves on supply of new PPDR ICT products and decreases their prices. In addition to cost savings, interoperability and availability of new PPDR ICT services improves. Traditionally good cooperation between different authorities in Finland enables development for the whole PPDR sector at the same time. This paper applies NABC framework for evaluating the on-going MOBI project and its results so far, and ensuring that the project continues as a right direction.

8.2 Governance Models

Jyri Rajamäki and Markus Vuorinen (2013a) studied "Multi-Supplier Integration Management for Public Protection and Disaster Relief (PPDR) Organizations". The research work focuses on the complex area of multi-supplier management. The main objective for this study is to designate how Public Protection and Disaster Relief (PPDR) organizations should operate within a multi-supplier service field. Dr. Rajamäki and Mr. Vuorinen generated a framework that provides a strategic tool to PPDR organizations to improve their sourcing strategies. The represented framework integrates Responsible, Accountable, Consulted and Informed (RACI) matrixes, ITIL-based service design, and Enterprise Service Management (ESM) as a strategic instrument for successful sourcing. The RACI matrices help to clarify responsibilities between suppliers. An Operational Level Agreement (OLA) is proposed to help interdependent relationships management between different suppliers. The ESM framework is referred as a "checklist" to inspect readiness for sourcing within the service design process.

One study by Rajamäki and Vuorinen (2013a) plays with the research theme of how PPDR organizations should choose their service delivery models for new digital services. These models are also valid for the mobile systems of ERVs. Their other study (Rajamäki & Vuorinen 2013b) discusses the benefits of standardizing ICT services.

Rajamäki, J. & Vuorinen, M. (2013a). Multi-Supplier Integration Management for Public Protection and Disaster Relief (PPDR) Organizations. In Proceedings of the 27th International Conference on Information Networking (ICOIN), pp. 499-504, ISBN: 978-1-4673-5741-8, Korea Institute of Information Scientists and Engineers (KIISE), Seoul, Korea

Abstract: Cloud sourcing and multi sourcing are growing rapidly and are success criteria's for today's IT departments. IT services are often operated by multiple suppliers but only very few of the client organizations are getting planned savings and service quality within multi-supplier environment. The Information

Technology Infrastructure Library (ITIL); Service Level Agreements (SLA) Management; Enterprise Service Management (ESM); Responsible, Accountable, Consulted, and Informed (RACI) matrix and selective sourcing practices have been created to respond to this problem but never aligned to be jointly used during service lifecycle. This paper presents a model how multi-supplier environments should be managed. New method presents how existing frameworks should be aligned from service management point of view. An attention is taken how Public Protection and Disaster Relief (PPDR) organizations should choose their service delivery model. Especially, if delivery is a mixture of in-house, outsourcing and cloud sourcing services, how to clarify the responsibilities, operating model and scorecards between suppliers? This new aligned model is described also graphically and the achieved benefits are described in detail.

Rajamäki, J. & Vuorinen, M. (2013b). Service Standardization to Utility Model: Process, Technology and Contracts. In Proc. the International Congress on Engineering and Information (2013 ICEAI), January 25.-27, Taipei, Taiwan.

Abstract: IT Services are currently delivered in very heterogeneous and customized delivery methods to client organizations. Clients have tailored processes, contracts and technology managed by both internal and external suppliers. The IT service terms, process and technology have been often fully tailored based on client organizations wishes. The next IT Megatrend - utility computing – is very controversy. In utility computing IT services are highly standardized. Same services are provided for multiple clients simultaneously to any device over the network with same terms and conditions. Suppliers have invested to automation to be able to provide the service to as many clients as possible with little or no manual work. With utility computing client organizations could achieve considerable savings, quality improvements and strategic initiatives as they would pay only based on the actual usage. The transformation journey from highly tailored service model to highly standardized services requires some careful preparations in order to succeed. This paper studies and presents that processes, technologies and contracts should be standardized in order organizations to be mature enough to take the benefits of utility computing. The benefits of standardization are described in detail as well some potential issues if standardization is not done.

8.3 Regional Development and Realization of Research

This dissertation addressed the realization of the regional development task of higher education in response to new regional and national challenges, such as integration of MOBI project, higher education functions and regional advances.

Pirinen, R. (2013a). Towards Regional development by Higher Education Institutions: An empirical study of a University of Applied Sciences. Doctoral Thesis. University of Oulu, University of Oulu Graduate School (UniOGS), Industrial Engineering and Management. Acta Universitatis Ouluensis, C 449, Oulu 2013, Finland.

Abstract: This thesis addresses the realisation of the regional development task of higher education in response to new regional and national challenges. This regional study investigates how the third task of regional development can be understood and was addressed at Laurea University of Applied Sciences (UAS). In this qualitative study as research continuum: action research is used in the investigation of an organisational-regional change, the integrated perspective of the design research is in the systemising of design and a multiple case study research is integrated for bringing an understanding of a research scope and in addition it can produce new knowledge for design and action. The unit of analysis was a case study and the analysis was undertaken using empirical, in-depth data collected between May 2001 and September 2012.

This study provides new and critical insights into the integration of regional development and regionally focused higher education within emergent value networks. In the centre of the study, there is the collectively developed integrative model at Laurea UAS, specifically, the student centred integration of regional development, research and development (R&D) and higher education functions. Here, in this operative environment, close proximity with an integrated web of R&D activities and projects produces new knowledge. This investigation into the new “third task” of the regionally focused university focuses on the development of new knowledge from value networks and externalities, within which R&D activities steer the direction of new knowledge. This research uses an integrative model to examine the dynamic workings of an emerging networked innovative collaborative environment, consisting of UAS spin-offs and initiatives for knowledge-based economic development, and strategic alliances between the actors of the regional knowledge flows that are rapidly extending towards more global networking and interaction with international externalities.

This dissertation investigated the realization of research and development (R&D) functions in a university of applied sciences (UAS). The purpose of thesis was to improve issues relevant to the integration of R&D related higher education studies and the national research agenda, such as research subjects in MOBI.

Pirinen, R. (2013b). Towards Realization of Research and Development in a University of Applied Sciences. Doctoral thesis. University of Eastern Finland (UEF), School of Computing, Eastern Finland Doctoral Program in Computer Science and Engineering. Publications of the University of Eastern Finland, Dissertations in Forestry and Natural Sciences, No 108, Kuopio 2013, Finland.

Abstract: This study investigates the realization of research and development (R&D) of higher education institutions in response to the progress of information systems, security management, and service programs in a university of applied sciences (UAS) between

2003 and 2012. This study addresses to the integrated and student-centered R&D projects at Laurea UAS, which are advances by R&D collaboration and agenda within master's, bachelor's, and degree education in the programs of information systems (n=528 students in 2012), security management (n=403), and services (n=676). Altogether there were 7740 students at Laurea in 2012.

In this continuum of research, case study research (CS) provides an understanding of an object and can extend knowledge or add strength to what is already known through previous research. In addition, it can produce new knowledge for design and action. Action research (AR), as an extension of quality system, is used in the investigation of change. It focuses on the research of educational change, relations, models, and interactions. The integrated perspective of the information system's design research (DR) is in the systemizing of design – it focuses on research for building, improving, and evaluating artifacts, such as models, methods, constructs, information systems, and services for implementation of the change. In addition, these three research methods were used in the implementation and improvement of R&D-related study units in the programs by students.

The first study provides contributions to the integration of education by presenting the integrative process, which is seen as action logic of the integrative model for bridging a world of cyclic strategies, visions, thinking, and imagination-creativity activities to linear R&D and development-based activities, as well as integrating focused R&D profiles and the national R&D agenda with an emergent value network. The second study consists of analysis of R&D- and strategy-based actualization of the new study unit. The third study includes integrated CS and DR for designing and actualizing a competence-based curriculum model of the degree program of business information technology. The fourth study analyzes two canonical AR (CAR) cycles, which were based on the realizations of the learning by developing (LbD) model and also the data of evaluations by FINHEEC (Finnish Higher Education Evaluation Council) between 2003 and 2009. The fifth study analyzes the cumulative data collection in regard to the R&D project SATERISK (satellite positioning risks), as a student-centered R&D project, activities, factors, and quality. The study also refers to the two latest FINHEEC evaluations and related research cycles, the evaluation of quality systems, and the evaluation of student-centered R&D between 2009 and 2011. Finally, the sixth study is a multiple case study analysis of 11 externally funded R&D projects concerning actualizations of R&D-based study units and realization of R&D tasks at Laurea UAS between 2008 and 2012.

The main new models contributed consist of three proposals: the integrative process model; the collectively developed LbD model, which was seen as a dimensional model of creative learning culture; and the concept of student-centered R&D. The answers to the R&D realization question in the six studies indicate that various forms of R&D activities can serve individuals, organizations, and entire domains. The integrative model is seen as one new proficient model for the future, and it can advance issues such as: 1) development of R&D capabilities; 2) joining the agenda-based R&D activities for collective education; 3) fitting together the strategies of domain, emergent R&D profiles, and education processes; 4) improvement of knowledge reserves; 5) raising the students'

participation in R&D so that they are the activating forces in the collaborative R&D; 6) teachers in continuous interaction with the environment, which allows for quick reactions to changing, agile and dynamic needs; and 7) a guide of teachers' R&D-related activities and collective thinking.

Some of the central challenges faced by the six studies consist of: 1) continuous change poses great challenges for teachers; 2) establishment of the new management culture and controlling the mass of projects precipitated by the R&D-related education; 3) balancing and modularizing of cognitive load and challenges; 4) improving a signification of the student-centered R&D in the perspective of communities of work; 5) development of incipient internationalization and knowledge economy; 6) measuring of impacts and development of utility, usability, and strategic measuring as an evaluation design structure in a general; and 7) dissemination of the new R&D-related model in context of higher education institution. In context of study, the first externally funded R&D project was started in August 2007, and by the end of this research, the volume of R&D was 12.5 M€ at Laurea.

In the conclusion, I outline that integrative process within student-centered R&D are based on and include collective R&D. Here, the R&D-related education comprises an individual's mind-on and hands-on activities, social interaction, creating something new within R&D, and knowledge sharing and collaboration between communities of work and communities of R&D.

Finally, the quality of research is discussed and future research questions are presented with their implications and final remarks.

References

- Carlson, C. R. & Wilmot, W. W. (2006). *Innovation: The Five Disciplines for Creating What Customers Want*, 1st Ed., Crown Business, New York: Random House.
- Pirinen, R. (2013a). *Towards Regional development by Higher Education Institutions: An empirical study of a University of Applied Sciences*. Doctoral Thesis. University of Oulu, University of Oulu Graduate School (UniOGS), Industrial Engineering and Management. Acta Universitatis Ouluensis, C 449, Oulu 2013, Finland.
- Pirinen, R. (2013b). *Towards Realization of Research and Development in a University of Applied Sciences*. Doctoral thesis. University of Eastern Finland (UEF), School of Computing, Eastern Finland Doctoral Program in Computer Science and Engineering. Publications of the University of Eastern Finland, Dissertations in Forestry and Natural Sciences, No 108, Kuopio 2013, Finland.
- Rajamäki, J. (2012). *Designing the Future Emergency Service Vehicle: Needs, Approach, Benefits and Competition*. Nordic and Baltic Journal of Information and Communications

Technologies [In review]. (Presented at the Conference of Next generation Public Safety and Emergency -Technologies, Policies and Business perspectives 10-11 December 2012, AAU Copenhagen, Denmark.)

Rajamäki, J. & Vuorinen, M. (2013a). Multi-Supplier Integration Management for Public Protection and Disaster Relief (PPDR) Organizations, in Proceedings of the 27th International Conference on Information Networking (ICOIN), January 27-31, Bangkok, Thailand.

Rajamäki, J. & Vuorinen, M. (2013b). Service Standardization to Utility Model: Process, Technology and Contracts. In Proc. the International Congress on Engineering and Information (2013 ICEAI), January 25.-27, Taipei, Taiwan.

9 Discussion and Conclusions

Jyri Rajamäki, Juha Knuuttila & Ilkka Tikanmäki

Due to the economic situation, the budgets for public protection and disaster relief (PPDR) are cut down, which in turn increases the pressure for developing novel innovations to ensure adequate computational capabilities and resources in every operative scenario. In field operations, the first responders' (FRs') most important tool is their vehicle. The Finnish approach to provide digital services to the field for FRs is via their vehicles. In Finland, border patrol, customs and police cars are already quite similar (except in colour), because these all are equipped by the Police Technical Centre. Also, other emergency response vehicles (ERVs), such as fire trucks and ambulances, have similar needs for a navigation system, patrol tracking, target maps, activity logs, alarms and remote access to central databases as well as control of blue lights and sirens, power supply systems and communications equipment. Also, the inventory of ERVs' equipment means on a weekly basis the number of hours used in the examination of goods, all of which are out being used in the field.

It is vital for Finland and all of Europe that different public protection and disaster relief organizations develop a common emergency response vehicle concept together. This enables new mobile digital services for first responders to their field operations. The MOBI research project has been an essential feasibility study to learn about the requirements of all PPDR organizations and first responders in the field. However, more multidisciplinary research is needed.

9.1 Recommendations for Procurements

9.1.1 PPI, PCR and POV

Public procurement of innovative solutions (PPI) means procurement where contracting authorities act as a launch customer for innovative goods or services that are not yet available on a large-scale commercial basis and may also include conformance testing (Edler and Georghiou, 2007).

In Pre-Operational Validation (POV), the main focus is on assessing and validating existing systems, whereas in Pre-Commercial Procurement (PCP), the main focus is on creating new innovations. According to the ECORYS study (2011), the concept of POV was introduced in July 2011 when the 5th FP7 call for security was released. The ECORYS report thus mentions

POV but does not go much deeper because the concept was fairly new at the time the study was written. Therefore, the concept of POV should be further defined and differentiated from PCP.

In principle, PPI, PCP and POV give better possibilities for small and medium enterprises (SMEs) to participate in procurement projects due to the lower entry barrier, but procurement procedures are seen as being too complex for SMEs due to limited resources and experience in procurement procedures. Therefore, the bottlenecks that limit or hinder the possibilities of SMEs to actively participate in public procurement projects in general and especially in the field of security should be further identified and investigated. In this respect, a two-layer approach is proposed, enabling firstly an overall description of the challenges faced by SMEs in public procurement and secondly a deeper analysis on the most relevant topics that the investigation will highlight. A special focus should be targeted to small businesses with limited knowledge and experience in public procurement procedures and their related requirements.

The European Network of Law Enforcement Technology Services (ENLETS) was set up in 2008 under the French Presidency of the Council with the aim of gathering user requirements, scanning and raising awareness of new technology and best practices, benchmarking and giving advice. As stated in the Council's conclusion, ENLETS could further enhance proper coordination between member states for public procurement and become a leading European platform for strengthening the internal security authorities' involvement in security-related research and industrial policy, thus bridging the gap between the end-users and providers of law enforcement technologies (Padding, 2013).

Due to the significance and latest developments in the public procurement of innovative solutions, the MOBI project would benefit from further reviews and analysis of Pre-Commercial Procurement (PCP) and Pre-Operational Validation (POV). Analyzing and reviewing the most advanced PCP and POV schemes would benefit the overall understanding of procurement issues. Moreover, the new projects should look for ways to develop customer savvy in designing and carrying out PPI projects. Benchmarking with leading R&D-intensive industries regarding the purchasing of R&D services would give a broader view and a better understanding of the business environment and best practices followed by leading private companies to complement the best practices followed by public procurers. The avoidance of risk typical of many procuring organizations and the "faster horse syndrome" limit the transfer to new and more advanced technologies. Finally, the projects should duly note the Council's conclusion on strengthening the internal security authorities' involvement in security-related research and industrial policy and thereby recognize the importance of the European Network of Law Enforcement Technology Services (ENLETS).

9.1.2 Maturity Levels

The role of business continuity and IT continuity management is to identify business requirements and provide solutions that ensure the continuity of information services and the capability to recover in case of disruptions or interruptions. Especially large

organizations have a considerably large number of information services, and they have a need to implement target-oriented and commonly accepted management models. This applies to IT continuity management processes and maturity models as well.

Syrjänen (2010a, 2010b) studied a large Finnish technology company that invests strongly in information technology due to a high dependency on information systems availability. This company developed and started to implement an IT continuity maturity model in the year 2007. Their maturity model is a combination of business continuity, IT governance and information risk management standards and best practices built on top of commonly used process-maturity models. Syrjänen's studies introduced the background and initial triggers for maturity-model development. In addition, maturity-model principles and usage cases were reviewed. The purpose of the study was to find out how much the IT continuity management maturity model had improved overall planning and the level of business continuity in the target organization. The core of Syrjänen's studies was the evaluation, the purpose of which was to evaluate the concrete benefits that the use of the maturity model had brought. The benefits were analyzed from five viewpoints: information service management, IT line units, IT governance, corporate governance including risk management, and the point of view of the individual. The evaluation was based on service quality reports, incident analyses, and continuity reports. In addition to the extensive report base, open discussions and feedback from the IT continuity community had a significant role while assessing the maturity-model value. The theoretical framework was mostly based on industry standards and best practices and the methods of canonical action research. Although the source material provided a solid base for the study, the confidentiality of information limited what and how much information could be shared in this study.

The five-level maturity model of Syrjänen (2010b) acts as a catalyst for IT continuity management implementation. The maturity status of each ICT system to be procured for PPDR actors should be validated according to the method presented by Syrjänen. Also, testing the readiness of extendibility of the selected systems needs to be studied as a part of POV.

9.2 Standardization

The European Commission, EUROPOL, and FRONTEX have recognized that the lack of interoperability limits the effectiveness of public safety practitioners in actual operations, and an evident lack of understanding as to whether these limitations arose from technology, operational procedures, and gaps in procurement or research (Baldini, 2010). A scientifically proven fact is that standardization strongly affects businesses that develop and sell technologies and technology-based products and services; standards are one main enabler for fast growth (Kivimäki, 2007). For improving interoperability, standardization development with like-minded countries should be started.

Regulations and standardization play an important role in applying the results of research to the market and to public safety end-users. The ongoing planning of a European external border surveillance system (EUROSUR) (Ameyugo et al., 2012) and EU's enhanced powers in

the field of internal security by the Treaty of Lisbon pave the way for further standardization efforts.

9.3 Connections between MOBI and Some Other Projects

Laurea has led several public safety-related projects that have connection with the MOBI project. Law enforcement and other PPDR operations are critical functions of society. The RIESCA (Rescuing of Intelligence and Electronic Security Core Applications) project studied the procurement and maintenance procedures of different critical information systems that support society. Patrol cars have such critical information systems. SATERISK (Risks of Satellite-based Tracking) project researched all kinds of technical, operational and legislative risks with regard to satellite-based tracking and navigation. These are vital services for patrol cars. The ongoing MACICO (Multi-Agency Cooperation In Cross-border Operations) project develops a concept for the interworking of different security organizations in their daily activity.

Another Finnish project that develops public safety ICT systems is the TUVE Information Security Network project, which provides the communications infrastructure for Finnish patrol cars. The KEJO field command system, which develops common field command systems for all Finnish PPRD actors, is another ongoing project. VITJA, the reforming project of the Finnish polices information systems, replaces almost all major operational information systems used by the Finnish police.

From the end-user and customer side, the Police Technical Centre has made a proposal for a pre-commercial procurement project aimed at a new patrol car. This PARVI project could be a straight continuum of the MOBI project, and it can make good use of most of the results of the MOBI project.

9.4 Further Work

During the MOBI project, society has changed radically. The application of social media has exploded, and authorities from advanced countries have taken these matters into account when developing their digital services for public safety. For example, with these advanced systems, those people who are on the scene of an accident first (whether involved or an eyewitness) can communicate with PPDR authorities who can receive social media and multimedia messages in their operative systems. Unfortunately, many PPDR organizations see the Internet and social media only as an extra resource from which they can collect and transpose “material” to analyze it in their own systems. In practice, too-strict data security regulations may rule out the mobile utilization of digital services in the field. However, most often the biggest cyber threat is the so-called “insider threat” as shown by the Snowden and Manning cases. When taking into account the Finnish cultural/ethnic environment, investment could be made in security originating from end-users, rather than the strict technical data security by which the last 0.02% of confidence can be achieved.

More research and development across two kinds of borders is needed.

Firstly, the typical borderlines between public customers and private vendors, where the tendering process is the main starting point of transaction, have to be modified towards pre-commercial procurement while prevailing R&D projects with front-line experience.

Secondly, national borderlines have to be crossed as well in order to form coalitions with enough niche-oriented purchasing volume to get tailored solutions for LEA's vehicles from industries' assembly lines. Even the richest small nations do not get the solutions wanted from automotive industry due to their limited volumes. Continued tailoring will not be sustainable in the long run.

Therefore, true standardization on the European level is needed. International warehouses of crime are truly international in developing their techniques. When will the LEAs be able to say the same?

References

Ameyugo, G., Art, M., Esteves, A.S. & Piskorski, J. (2012). Creation of an EU-level information exchange network in the domain of border security. In *Intelligence and Security Informatics Conference (EISIC)*, 2012 European, 2012, pp. 356-358.

Baldini, G. (2010). Report of the workshop on "Interoperable communications for Safety and Security. Publications Office of the European Union, 2010.

Edler, J. & Georghiou, L. (2007). Public procurement and innovation—Resurrecting the demand side. *Research Policy*, vol. 36, pp. 949-963, 9, 2007.

ECORYS (2011). Study on pre-commercial procurement in the field of security within the framework contract of security studies – ENTR/O9/O50. ECORYS Nederland BV, Rotterdam, The Netherlands, 2011.

Kivimäki, A. (2007). *Wireless Telecommunication Standardization Processes: Actors' Viewpoint*. Oulu: Oulun yliopiston kirjasto, 2007.

Padding, P. (2013). Security and safety. ENLETS. In *Conference on Innovation Procurement*, 2013.

Syrjänen, K. (2010a). Information technology (IT) perspective on maturity modelling and continuity management: An action and design research. In *Integrative Student-Centred Research and Development Work: Rescuing of Intelligence and Electronic Security Core Applications (RIESCA)*, R. Pirinen and J. Rajamäki, Eds. Vantaa: Laurea Publications, 2010, pp. 68-111.

Syrjänen, K. (2010b). Maturity-based continuity management. In Integrative Student-Centred Research and Development Work: Rescuing of Intelligence and Electronic Security Core Applications (RIESCA), R. Pirinen and J. Rajamäki, Eds. Vantaa: Laurea publications, 2010, pp. 68-111.

10 Yhteenveto (Finnish Summary)

Jyri Rajamäki, Juha Knuuttila & Ilkka Tikanmäki

10.1 Johtopäätökset ja jatkotutkimuskohteet

On tärkeää, että viranomaiset kehittävät yhteistä hälytysajoneuvokonseptia. Tämä mahdollistaa uusia digitaalisia palveluita kentälle. MOBI-tutkimushanke on ollut välttämätön esitutkimus, jolla on selvitetty käyttäjien ja käyttäjäorganisaatioiden tarpeita. Se on myös toiminut viestinviejänä loppukäyttäjiltä teollisuuteen.

Monitieteellistä tutkimusta tarvitaan kuitenkin lisää ja tämän tutkimuksen pohjalta olisi kehitettävä alan kansainvälistä standardointia. ICT-konseptin kehittäminen on huomattavan kallista, joten pääsy kansainvälisille markkinoille on suotavaa. Suomessa on hyvät mahdollisuudet kehittää turvallisuusviranomaisten yhteistä ICT-konseptia, koska viranomaisten keskinäinen yhteistyö on kehittynyttä ja tehokasta. Edellä mainitut ongelmat ovat samanlaisia kaikissa maissa: viranomaisajoneuvoihin joudutaan mm. lisäämään uusia ICT-laitteita ja -järjestelmiä. Välttämätöntä standardoitumista alalla ei ole tapahtunut. Alalle olisikin luotava kansainvälinen standardi (alan de facto- ja/tai de jure-standardoituminen), joka tehostaa ja helpottaa viranomaisten yhteistoimintaa sekä palveluiden hankintaa monitoimittajaympäristössä. Näitä ratkaisuja olisi myös mahdollista soveltaa muiden toimijoiden kuin viranomaisten käyttöön: esimerkiksi teollisuuden yrityksillä, yksityisellä turva-alalla ja fleet management -palveluissa on tarvetta liikkuvan toimiston kaltaiselle ajoneuvoratkaisulle. MOBI-hankkeessa kehitetty OSI-mallin kaltainen tasomalli hyödyttää jatkostandardoinnin tekoa loppukäyttäjien näkökulmasta.

Suomen poliisin osalta on varmistettava VITJA-järjestelmäuudistuksen edellyttämien teknisten vaatimusten käyttöönotto partioautoissa. Tällöin tarkasteluun tulevat ensisijaisesti: 1) mobiilit laajakaistaiset tietoliikennetkaisu, 2) VITJAn edellyttämät sovelluksen käyttömahdollisuudet partioautosta mobiiliyhteyksiä käyttäen, 3) valmiudet KEJO-kenttäjohtojärjestelmän käytölle partioautosta mobiiliyhteyksiä käyttäen, 4) oheislaitteiden, kuten kameroiden, tutkien ja automaattisen rekisteri-tunnistuksen käyttö mahdollisimman tehokkaasti, 5) tehokkaiden ja älykkäiden sähköntuottomenetelmien edelleen kehitys ja testaus, sekä 6) alustava ergonomisten (käyttöliittymät/muu toimintaympäristö) ratkaisuiden kartoitus ja mahdollinen käyttöönotto. Poliisin tekniikkakeskus on selvittänyt mahdollisuudet ulkopuoliseen rahoitukseen ja saanut TEKESiltä positiivisen rahoituspäätöksen innovatiiviselle esikaupalliselle PARVI-

hankkeelleen. Suomen viranomaisten tulisiikin hyödyntää tällaisia uusia rahoitusmahdollisuuksia. PARVI-hanke on hyvä väylä, jolla kansallisesti voidaan kehittää mobiilia konseptia tietylle tasolle: VITJAn ja KEJOn jalkauttaminen koko toimintaketjuun, jolloin palvelut ovat käytettävissä myös ajoneuvosta irrotettavissa laitteissa. Kumppanuus ajoneuvovalmistajien kanssa voidaan aidosti toteuttaa, mutta siihen tarvitaan kansainvälistä yhteistyötä ja standardointia. Euroopan osalta standardointia voisi johtaa esimerkiksi ENLETS (European Network of Law Enforcement Technology Services). Kumppanuus autonvalmistajien kanssa on lopulta välttämätöntä, jotta viranomaisten tarvitsemat palvelut ja järjestelmät voidaan aidosti integroida ajoneuvoon. Viranomaisten itsensä tekemä räätälöinti on erittäin aikaa vievää ja kallista.

MOBI-, TUVE-, KEJO- ja VITJA-hankkeiden kestäessä yhteiskunta on radikaalisti muuttunut: sosiaalisen median käyttö on räjähtänyt ja kehittyneemmät maat viranomaisineen ovat ottaneet nämä seikat huomioon digitaalisia palveluja uudistaessaan. Kehittyneimmissä järjestelmissä esimerkiksi ensimmäisinä onnettomuuspaikalle tulleet osalliset ja/tai silminnäkijät voivat viestiä tapahtumista viranomaisille, joilla on valmius ottaa vastaan onnettomuuteen liittyviä sosiaalisen median ja multimedia -viestejä operatiiviseen toimintajärjestelmäänsä. Tällä hetkellä monet viranomaiset näkevät Internetin ja sosiaalisen median vain lisäresurssina, josta kerätään ”materiaalia” siirrettäväksi ja analysoitavaksi omiin korkean turvallisuuden järjestelmiin. TUVE-hankkeen tietosuojamääräyksillä voidaan hankaloittaa hallittua mobiilikäyttöä sen verran, että viranomaiset jatkaisivat nykykäytännön mukaista epävirallista tietojenvälitystä henkilökohtaisten älypuhelimensa avulla multimediamiestein. Nykykäsityksen mukainen tosiasia on, että kyberturvallisuudessakin suurin riski on ns. insider threats, kuten Snowden- ja Manning -tapaukset osoittavat. Suomen kulttuuriyhtiön ympäristön huomioon ottaen olisi mahdollista panostaa tähän käyttäjistä lähtevään järjestelmien turvallisuuteen, eikä niinkään tietoteknisen viimeisen 0,02 % varmuuden saavuttamiseen.

10.2 Miten MOBI erottuu muista kehitysprojekteista?

Vastaavanlaisia ongelmia esiintyy kaikissa maissa ja monia hälytysajoneuvojen kehityshankkeita on käynnissä eri puolilla maailmaa. Kaikki nämä hankkeet keskittyvät tietyn tyyppisten ajoneuvojen kehittämiseen: kehitetään joko ambulanssia, poliisiautoa tai pelastusajoneuvoa. MOBI on ainoa hanke, joka kehittää yhteistä hälytysajoneuvokonseptia kaikille turvallisuusviranomaisille. Kerroksittainen lähestymistapa mahdollistaa yhteiset moduulit. Vaikka ambulanssi on erilainen kuin poliisiauto on sillä hyvin samankaltaiset tietoliikennetarpeet sekä monia samoja digitaalisia palveluita.

Kerroksittainen lähestymistapa tuo mukanaan viranomaisajoneuvolle samat hyödyt kuin OSI-malli toi tietoliikenteeseen. Kerrokset jakavat ajoneuvon sähkö-, elektroniikka- ja ICT-järjestelmät pienempiin ja yksinkertaisimpiin osiin. Pienemmät ja yksinkertaisemmat kokonaisuudet kannustavat komponenttien kehittämistä, suunnittelua ja ongelmanratkaisua. Standardoidut rajapinnat mahdollistavat modulaarisen järjestelmien kehittämisen; useat toimittajat pystyvät samanaikaisesti kehittämään sekä rauta- että ohjelmistokomponentteja ja silti ne pysyvät yhteensopivina. Muutokset yhdellä kerroksella eivät vaikuta toisten kerrosten toimintaan, mikä nopeuttaa kehitystyötä.

10.3 Hankkeen hallinto

Laurean MOBI-tutkimushankkeen (1.9.2010–31.3.2014) kokonaisbudjetti oli 800 000 €. Sen rahoittajina olivat Tekes 60 %, teollisuus 19 % (Cassidian Finland Oy [nykyisin osa Airbus Defence and Space divisioonaa], Insta DefSec Oy, Ajeco Oy ja Sunit Oy), loppukäyttäjät 5 % (Poliisihallitus ja Poliisin tekniikkakeskus) sekä Laurean omarahoitusosuus 16 %. Tutkimushankkeen päätavoite oli tuottaa tutkimustietoa kahdelle rinnakkaiselle yritysprojektille (vetäjinä Cassidian Finland Oy sekä Insta DefSec Oy) sekä viranomaisten omille hälytysajoneuvojen kehitysprojekteille. MOBI toteutettiin Laurean kehittämispohjaisen oppimisen (Learning by Developing – LbD) toimintamallin mukaisesti henkilökunnan, opiskelijoiden ja työelämäosaajien yhteistyönä. Tutkimustuloksia on toistaiseksi julkaistu mm. kolmessa väitöstutkimuksessa, kymmenessä tieteellisessä lehtiartikkelissa, 25 tieteellisessä konferenssiartikkelissa ja 31 opinnäytetyössä, joista 11 oli ylempiä tutkintoja.

10.4 Tarpeet

Kansalaiset tarvitsevat korkeatasoisia viranomaispalveluita muuttuvassa ympäristössä. Heidän pääasiallinen tarpeensa on saada vastinetta verorahoilleen. Tosiasia on, että tuottavuuden kasvu yksityisellä sektorilla on ollut huomattavasti suurempaa kuin julkisella sektorilla. Kuntasektorin suurin ongelma on väestön ikääntymisen mukanaan tuomat lisääntyvät menot ja siksi kunnilla on suuri tarve tuottaa kaikki palvelunsa entistä tehokkaammin. Kunnallisista palveluista tämä tarve koskee myös pelastustointia (ensihoito sekä palo- ja pelastuspalvelut). Suomessa lainvalvontaviranomaiset (poliisi, rajavartiolaitos, tullit) ovat valtiollisia toimijoita. Kansalaisten suojeleminen yhä organisoituneemmalta ja kansainvälistyneemmältä rikollisuudelta vaatii uusia työvälineitä. Suomessa on myös trendinä vähentää kiinteitä poliisiasemia ja kehittää poliisiautoista liikkuvia toimistoja, jotka täyttävät tieto- ja viestintäteknologiasta (ICT).

Kaikki turvallisuusviranomaiset (pelastustoimi sekä lainvalvontaviranomaiset) tarvitsevat hyvät toimintaolosuhteet. Heidän on ylläpidettävä ydintoimintansa yhä pienenevillä toimintamäärärahoilla. Tämän yhtälön toteuttamiseksi ainoa mahdollisuus on ICT:n entistä parempi hyödyntäminen - myös kentällä, jossa ajoneuvo on turvallisuusviranomaisten tärkein työväline. Euroopan komission ja Euroopan unionin ulkorajayhteistyöstä huolehtivan viraston (Frontex) yhteisessä workshopissa 2010 todettiin: suurimmat ongelmat turvallisuusviranomaisten kenttätöössä ovat viranomaisten välisen yhteistyön puute sekä laajakaistayhteyksien puute.

Suomessa kunnat yhdistyvät; tällöin myös palo- ja pelastusasemia yhdistetään. Tämän seurauksena toiminta-alueet kasvavat, mikä helposti vähentää pelastushenkilöstön paikallistietämystä. Tämän ongelman ratkaisuksi tarvitaan parempia teknologisia palveluita. Nykyiset ambulanssit ovat puolestaan enemmän liikkuvia sairaaloita kuin potilaiden nopeaan kuljetukseen tähtääviä ”potilastakseja”. Myös tämä kehitys tarkoittaa teknologian lisääntymistä hälytysajoneuvoihin. Lainvalvontaviranomaisten osalta on käynnissä kehityssuunta, jossa toimistossa istumista vähennetään ja kentällä oloa lisätään. Tällöin myös rikosteknisten järjestelmien liikkuvat ohjaus- ja valvontatarpeet lisääntyvät.

Viranomaisten ajoneuvoihin on vuosikymmenten kuluessa lisätty kymmenittäin erillisiä teknisiä laitteistoja, jotka vaativat huomattavasti tilaa ja joilla on omat käyttöliittymänsä ajoneuvon ohjaamossa. Tämä on johtanut ajoittaisiin toiminnallisuusongelmiin (esimerkiksi turvatyynyn toimintatilan supistuminen) ja teknisiin ongelmiin sähkönsaannissa ja kaapeloinneissa. Sovelletujen ratkaisujen dokumentointi on ollut vaihtelevaa eikä kaivattua standardoitumista alalla ole tapahtunut laitetoimittajien moninaisuudestakin johtuen. Suomen vuosittaiset toimitusvolyymit ja hankintakulttuuri eivät ole edesauttaneet tällaista kehitystä. Toisaalta teknologian ja palveluiden tarjoajat kaipaavat liiketoimintamahdollisuuksia ja heidän kannaltaan ongelmana on pirstaleinen toimintaympäristö: eri viranomaisilla on omat vaatimuksensa, kunnallisilla viranomaisilla vaatimukset voivat vaihdella kunnittain, eri maissa vaatimukset saattavat olla hyvinkin erilaiset. Siviiliviranomaisilta puuttuu usein samanlainen hankintaosaaminen kuin sotilasviranomaisilla on.

10.5 Lähestymistapa

MOBI-tutkimushanke on kehittänyt viranomaisajoneuvon sähkö-, elektroniikka- ja ICT-järjestelmille kerroksittaisen moduulisen toteutusmallin, jossa kerrosten välillä on standardoidut rajapinnat. Nämä kerrokset ovat: 1) ajoneuvon infrastruktuuri ja energian hallinta, 2) tietoliikennekerros, 3) yhteiset palvelut, sekä 4) eri viranomaisten erityiset palvelut (Rajamäki 2013). MOBI-tutkimushankkeessa varusteltiin demo-ajoneuvo, jossa kehitettiin ja testattiin erilaisia teknologioita.

Alimman kerroksen muodostaa ajoneuvon infrastruktuuri, jonka yksi vaikeimmista ongelmista on energian hallinta. Tämän kerroksen standardeilla pyritään ratkaisemaan seuraavat kysymykset: Mitä standardi-ajoneuvon palveluita hyödynnetään? Miten hälytysajoneuvon tarvitsemat muutos- ja asennustyöt standardoidaan? Standardi-ajoneuvosta hyödynnettäviä palveluita ovat muun muassa energian tuotanto moottorin käydessä, tietojen lukeminen ajoneuvon CAN-väylästä (esim. akkujännite) ja toimintojen ohjaus CAN-väylän välityksellä (esim. hälytys-, ajo- ja työvalot, keskuslukitus). Standardoitavia muutos- ja asennustöitä ovat mm. hälytysvalojen ja -laitteiden asennukset, älykäs tehonhallintajärjestelmä (energian tuotanto myös silloin kun ajoneuvon moottori on sammutettuna, energian varastointi ja energian priorisoitu jakelu), kaapelointi ja antennien asennukset sähkömagneettinen yhteensopivuus huomioiden. Demo-ajoneuvossa testattiin mm. älykästä energian varastointia (Kämppe & Rathod 2013), josta on tehty myös keksintöilmoitus.

Tietoliikennekerros sisältää kolme standardointitasoa: 1) pitkän matkan yhteydet, 2) ajoneuvon paikallisverkko, sekä 3) likiverkko ja lisälaitteyydet. Näissä kaikissa tasoissa on huomioitava sekä puhe- että dataliikenne. Pitkän matkan yhteydet käsittävät ajoneuvon ja johtokeskuksen väliset yhteydet sekä ajoneuvojen väliset yhteydet ajoneuvojen ollessa etäällä toisistaan. Yhteyksissä hyödynnetään useita yhtäaikaaisia radio-teknologioita ja verkkoja, kuten TETRA/TETRAPOL, kaupalliset 2G/3G/4G, satelliittiyhteydet sekä WAN (WLAN-hotspot + Internet). Ajoneuvon paikallisverkko -taso käsittää sekä langalliset että langattomat paikallisverkot ajoneuvon sisällä ja sen välittömässä läheisyydessä. Langatonta paikallisverkkoa kannattaa hyödyntää myös ajoneuvojen välisessä ad-hoc

tiedonsiirrossa kenttäoperaatioissa, kun ajoneuvot ovat lähellä toisiaan, sekä asemalla ajoneuvon suuria tietomääriä sisältäviä järjestelmiä päivitettäessä (esim. karttojen päivitys). Likiverkko ja lisälaitteyksissä on huomioitava toiminnan kannalta tarpeellisten palveluiden mukaan saaminen ajoneuvosta poistuttaessa. Demo-ajoneuvossa testattiin mm. monikanavaista tietoliikennettä Ajecon DSiP protokollan avulla sekä Thurayan satelliittiyhteyksiä. Molemmat teknologiat toimivat testeissä hyvin.

Yhteisten palveluiden -kerros tuottaa kaikille turvallisuusviranomaisille yhteiset palvelut sekä alustan, jolla eri viranomaisten toimialakohtaiset palvelut voidaan jakaa. Kaikille viranomaisille yhteisiä palveluita ovat mm. navigointi, partioiden seuranta, kohdekartat ja -tiedot, tehtävälistat, hälytyslaitteiden ohjaus sekä pääsy erilaisiin datatietoihin. Karkeasti jaettuna yhteisten palveluiden kerroksen standardoinnin päätavoitteet ovat: 1) yhteinen perusarkkitehtuuri, 2) yhteinen kenttäjohtojärjestelmä sekä 3) erilaisten fyysisten käyttöliittymien lukumäärän vähentäminen. Yhteinen perusarkkitehtuuri kannattaa rakentaa modulaarisena palvelukeskeisen arkkitehtuurin (service-oriented architecture, SOA) pohjalta hybridi pilvipalveluita hyödyntäen. Yhteinen kenttäjohtojärjestelmä (KEJO) tulee suunnitella niin, että se toimii yhteisenä käyttöliittymänä mahdollisimman monille palveluille. Näin fyysisten käyttöliittymien määrä vähenee. Tietojen suojaamisessa kannattaa hyödyntää pilvipalveluita siten, että ajoneuvossa ei säilytetä luokiteltavaa tietoa ja siten tulla tältä osin KATAKRI-vaatimusten piiriin. Hajautettujen järjestelmien ja sipulimallin (tietojen suojaaminen kovenee asteittain sitä mukaa mitä kriittisimmiksi tiedot tulevat) käyttäminen on suositeltavaa. Demo-ajoneuvossa testattiin mm. TETRA-ajoneuvopäätelaitteen käyttöliittymän yhdistämistä ajoneuvotietokoneen kosketusnäyttöön. Testissä todettiin mm. tarve erilliselle hälytysajomoodille, jolla käyttöliittymää pystyy käyttämään myös suuremmissa ajonopeuksissa.

Viranomaisilla on tarpeita myös omille toimialakohtaisille digitaalisille palveluilleen, kuten poliiseilla kameroiden, tutkien ja automaattisen rekisteri-tunnistuksen käyttöön mahdollisimman tehokkaasti. Mahdollisuuksien mukaan myös nämä palvelut tulisi kytkeä yhteiseen kenttäjohtojärjestelmään standardoidun rajapinnan kautta, jolloin käyttöliittymien määrä pysyisi hallinnassa. Esimerkiksi miehittämättömien lennokkien ohjaus- ja valvontafunktiot tulisi integroida yleiseen kenttäjohtojärjestelmään (Tikanmäki 2011). Nykyisten tieto- ja viestintäjärjestelmien toimiessa monitoimittajaympäristössä vaaditaan viranomaisilta uudenlaista hankinta- ja ylläpito-osaamista (Rajamäki & Vuorinen 2013).

Lähteet

Kämppi, P. & Rathod, P. (2013). Smart Battery System for Emergency Vehicles: Results from a Pilot Field Study. 2nd International Conference on Connected Vehicles & Expo. Las Vegas, Nevada, U.S.A. (In print).

Rajamäki, J. (2013). The MOBI Project: Designing the Future Emergency Service Vehicle. IEEE Vehicular Technology Magazine, vol.8, no.2, June 2013, 92-99.

Rajamäki, J. & Vuorinen, M. (2013). Multi-supplier integration management for public protection and disaster relief (PPDR) organizations, In proceedings of the 27th International Conference on Information Networking (ICOIN) January 27.-31, Bangkok, Thailand.

Tikanmäki, I. (2011). Possibilities to Operational Use of Remotely Piloted Aircrafts in Finland. Master Thesis. Theseus. Espoo: Laurea.

Project information

Project name	MOBI
Project type	Research project
Tekes' funding share	480 000€
Tekes' program	Safety and security
Start date	9/1/10
End date	3/31/14

Contact information

Company/Organisation	Laurea-ammattikorkeakoulu Oy
Research Director	Dr Jyri Rajamäki





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List of Publications

Doctoral Theses

Pirinen, R. (2013a). Towards Regional development by Higher Education Institutions: An empirical study of a University of Applied Sciences. Doctoral Thesis. University of Oulu, University of Oulu Graduate School (UniOGS), Industrial Engineering and Management. Acta Universitatis Ouluensis, C 449, Oulu 2013, Finland.

Pirinen, R. (2013b). Towards Realization of Research and Development in a University of Applied Sciences. Doctoral thesis. University of Eastern Finland (UEF), School of Computing, Eastern Finland Doctoral Program in Computer Science and Engineering. Publications of the University of Eastern Finland, Dissertations in Forestry and Natural Sciences, No 108, Kuopio 2013, Finland.

Sihvonen, H-M. (2012). Studies on Software Process Improvement in Organizational Changes. Doctoral Thesis. University of Eastern Finland. Publications of the University of Eastern Finland, Dissertations in Forestry and Natural Sciences No 72. Kuopio 2012, Finland.

Journals

Ahokas, J., Guday, T., Lyytinen, T. & Rajamäki, J. (2012). Secure and Reliable Communications for SCADA Systems. International Journal of Communications, Issue 3, Volume 6, pp. 167-174.

Ahokas, J., Rajamäki, J. & Tikanmäki, I. (2012). Secure and Redundant Public Safety Communication Network for Public Protection and Disaster Relief (PPDR) Organizations. International Journal of Communications, Issue 3, Volume 6, pp. 120-127.

Holmstrom, J., Rajamäki, J. & Hult, T. (2011). The Future Solutions and Technologies of Public Safety Communications - DSIP Traffic Engineering Solution for Secure Multichannel Communication. International Journal of Communications, Issue 3, Volume 5.

Lehto, J., Rajamäki, J. & Rathod, P. (2012). Cloud Computing with SOA Approach as Part of the Disaster Recovery and Response in Finland. International Journal of Computers and Communications. Issue 3, Volume 6, pp. 175-182.

Rajamäki, J. (2013). The MOBI Project: Designing the Future Emergency Service Vehicle. IEEE Vehicular Technology Magazine, vol.8, no.2, June 2013, 92-99.

Rajamäki, J., Hult, T. & Ofem, P. (2011). ICT Integration of Public Protection and Disaster Relief: Services for Fire and Rescue Personnel. *International Journal of Computers and Communications*, Issue 3, Volume 5.

Rajamäki, J., Tervahaltiala, J., Tervola, S., Johansson, S., Ovaska, L. & Rathod, P. (2012). How Transparency Improves the Control of Law Enforcement Authorities' Activities? *IEEE Computer Society Conference Publishing Services (CPS)*, Washington DC, USA.

Rajamäki, J. & Villemson, T. (2010) Creating a service oriented architectural model for emergency vehicles. *International Journal of Communications*. Issue 1, Volume 3, pp. 44-53.

Tikanmäki, I., Tuohimaa, T. & Rajamäki, J. (2011). How and why Unmanned Aircraft Vehicles can improve Real-time awareness? *International Journal of Circuits, Systems And Signal Processing*, Issue 5, Volume 5.

Tuohimaa, T., Tikanmaki, I. & Rajamaki, J. (2011). Cooperation Challenges to Public Safety Organizations on the Use of Unmanned Aircraft Systems (UAS). *International Journal of Systems Applications, Engineering & Development*, Issue 5, Volume 5.

Peer-Reviewed Conference Papers

Holmström, J., Rajamäki, J. & Hult, T. (2011). DSIP Distributed Systems intercommunication Protocol - A Traffic Engineering Solution for Secure Multichannel Communication. 10th WSEAS International Conference on Applications of Computer Engineering. Playa Meloneras, Gran Canaria, Canary Islands, Spain.

Hult, T. & Rajamäki, J. (2011). ICT Integration of Public Protection and Disaster Relief (PPDR): Mobile Object Bus Interaction (MOBI) Research and Development Project. 10th WSEAS International Conference on Applications of Computer Engineering. Playa Meloneras, Gran Canaria, Canary Islands, Spain.

Kurki, T. & Sihvonen, H-M. (2012). Role Management Approach for Emergency Organizations. The 45th Hawaii International Conference on System Sciences (HICSS-2012). Maui, Hawaii.

Kämppi, P. & Rathod, P. (2013). Smart Battery System for Emergency Vehicles: Results from a Pilot Field Study. 2nd International Conference on Connected Vehicles & Expo. Las Vegas, Nevada, U.S.A. (In print).

Lehto, J., Rajamäki, J. & Rathod, P. (2012a). Conceptualised View on Can Cloud Computing Improve the Rescue Services in Finland? Proceeding of the 11th WSEAS international conference on Applied Computer and Applied Computational Science, April 18.-20, Rovaniemi, Finland.

Ofem, P. & Rajamäki, J. (2014). Service Oriented Architecture: An Enabler of ICT Integration and Optimization in Public Protection and Disaster Relief Services. Proceedings of the 8th International Conference on Communications and Information Technology (CIT '14), Tenerife, Spain, January 10-12, 2014, pp. 346-359.

Rajamäki, J. (2014). Cross-border Information Exchange between Law Enforcement Authorities. Proceedings of the 8th International Conference on Communications and Information Technology (CIT '14), Tenerife, Spain, January 10-12, 2014, pp. 205-210.

Rajamäki, J. (2013). Mobile digital services for border protection: Standardization of emergency response vehicles. Intelligence and Security Informatics Conference (EISIC), 2013 European, 256-261.

Rajamäki, J., Holmström, J. & Knuuttila, J. (2010). Robust Mobile Multichannel Data Communication for Rescue and Law Enforcement Authorities. 17th IEEE Symposium on Communications and Vehicular Technology in the Benelux. November 24.-25, University of Twente, The Netherlands.

Rajamäki, J. & Knuuttila, J. (2013). Law Enforcement Authorities' Legal Digital Evidence Gathering Legal, Integrity and Chain-on-custody Requirement. European Intelligence and Security Informatics Conference. August 12.-14.2013 Uppsala, Sweden.

Rajamäki, J. & Kämppe, P. (2013a): Mobile Communications Challenges to Cross-border Tracking Operations Carried out by Law Enforcement Authorities. In Proc. the International Conference on Information Networking 2013 (ICOIN 2013), January 27.-30, Bangkok, Thailand.

Rajamäki, J. & Kämppe, P. (2013b): Secure and Reliable Satellite-based Tracking System for Emergency Management. In Proc. the International Congress on Engineering and Information (2013 ICEAI) January 25-27, Taipei, Taiwan.

Rajamäki, J. & Rathod, P. (2013). Service Standardization with utility computing and service oriented architecture as a tool for public protection and disaster relief. Proceeding of the EISIC 2013 Conference Poster Session. August 12, Uppsala, Sweden.

Rajamäki, J., Rathod, P. & Kämppe, P. (2013a). A New Redundant Tracking System for Emergency Response. European Intelligence and Security Informatics Conference. August 12.-14.2013 Uppsala, Sweden.

Rajamäki, J., Rathod, P. & Kämppe, P. (2013b). Hybrid Multi-Channel and Redundant Tracking System in Emergency Response. In Recent Advances in Computer Engineering Series, vol. 16: Proceedings of the 2nd International Conference on Information Technology and Computer Networks (ITCN '13), pp. 177-182.

Rajamäki, J., Tervahaltia, J., Tervola, S., Johansson, S., Ovaska, L. & Rathod, P. (2012). How Transparency Improves the Control of Law Enforcement Authorities' Activities?

European Intelligence and Security Informatics Conference. August 22.-24, Odense, Denmark.

Rajamäki, J., Timonen, T., Nevalainen, J., Uusipaavalniemi, H., Töyrylä, T. & Arte, E. (2014). "Human-machine interactions in future police vehicles: Applying Speech User Interface and RFID Technology," *International Journal of Systems Applications, Engineering & Development*, Volume 8.

Rajamäki, J. & Villemson, T. (2009). Designing Emergency Vehicle ICT Integration Solution. In *Proc. 3rd International Conference on Communications and Information Technology*. December 29.-31, Athens, Greece.

Rajamäki, J. & Vuorinen, M. (2013a). Multi-Supplier Integration Management for Public Protection and Disaster Relief (PPDR) Organizations, in *Proceedings of the 27th International Conference on Information Networking (ICOIN)*, January 27.-31, Bangkok, Thailand.

Rajamäki, J. & Vuorinen, M. (2013b). Service Standardization to Utility Model: Process, Technology and Contracts. In *Proc. the International Congress on Engineering and Information (2013 ICEAI)*, January 25.-27, Taipei, Taiwan.

Rathod, P. & Kämppi, P. (2013). User Requirements of Emergency Response Vehicles: Preliminary Findings from a Current Research Study. *2nd International Conference on Connected Vehicles & Expo*. Las Vegas, Nevada, U.S.A. (In print).

Roisko, V., Kämppi, P. & Luojus, S. (2013). Touch Screen Based TETRA Vehicle Radio: Preliminary Results of Multi-methodology Usability Testing Prototype. *2nd International Conference on Connected Vehicles & Expo*. Las Vegas, Nevada, U.S.A. (In print).

Sihvonen, H-M. & Kurki, T.A. (2010). Role Management Diversity in Emergency Situations. *IEEE International Conference Technologies for Homeland Security*. November 8.-10, Westin Boston-Waltham Hotel, Boston, MA, United States of America.

Timonen, T. & Rajamäki, J. (2013). RFID Technology as an Inventory Tool for Future Emergency Service Vehicles. In *Recent Advances in Computer Engineering Series*, vol. 16: *Proceedings of the 2nd International Conference on Information Technology and Computer Networks (ITCN '13)* edited by Sergio Lopes, pp. 142-145, WSEAS Press.

Villemson, T. (2011) User centric research in the MOBI-project. In O. Kallioinen (Ed.) *Learning by Developing-New ways to learn. Proceedings of the 3rd Conference on Future Expertise in Higher Education*, Vantaa: Laurea University of Applied Sciences, 144-157.

Conference Presentations and Submitted Papers

Kämppi, P. (2013). Living Lab implementations in the MOBI project. TIEMS Workshop on Smart Environments and ICT Systems Living Lab for Societal Security, 26-27 September 2013, Espoo, Finland.

Kämppi, P. & Rathod, P. (2013). Smart Battery System for Emergency Vehicles: Results from a Pilot Field Study. 2nd International Conference on Connected Vehicles & Expo. Las Vegas, Nevada, U.S.A. (In print).

Ofem, P. & Rajamäki, J. (2014) Service oriented architecture as an enabler of ICT integration and optimization in public protection and disaster relief services: case study of medical emergency services in Finland, International Journal of Computers and Communications. [In Press]

Rajamäki, J. (2012). Designing the Future Emergency Service Vehicle: Needs, Approach, Benefits and Competition. Next generation Public Safety and Emergency -Technologies, Policies and Business perspectives 10-11 December, AAU Copenhagen, Denmark.

Rajamäki, J. (2012). Decentralized cyber secure public safety communications and information management systems for a multi organizational environment. Plenary Lecture 2. The 3rd International Conference on Energy, Environment, Devices, Systems, Communications, Computers (INEEE'12), Rovaniemi, Finland, April 18-20.

Rajamäki, J. (2013). Future Emergency Vehicles' ICT Services. Invited Plenary Lecture. Recent Advances in Computer Engineering Series, vol. 16: Proceedings of the 2nd International Conference on Information Technology and Computer Networks (ITCN '13) edited by Sergio Lopes, p. 15, WSEAS Press.

Rathod, P & Kämppi, P. (2013). User Requirements of Emergency Response Vehicles: Preliminary Findings from a Current Research Study. In Proceedings of the 2nd IEEE International Conference on Connected Vehicles & Expo (ICCVE 2013), December 2-6, Las Vegas, Nevada, USA.

Theses

Ahokas, J. (2013). Secure and Reliable Communications Solution for SCADA and PPDR use. Master thesis. Theseus. Espoo: Laurea.

Alaverronen, S. (2012). Liikennemäärien visualisointi Javalla DSiP-lokitiedostoista. Thesis. Theseus. Espoo: Laurea (in Finnish).

Bertling, M. (2011). Kytcentöjen määrän visualisoiminen Javalla DSiP-lokitiedostoista. Thesis. Theseus. Espoo: Laurea (in Finnish).

- Erkkilä, H. & Sillanpää, L. (2013). Viestintä VIRVE-viranomaisradioverkossa ja sen kehittäminen: Kirjallisuuskatsaus. Thesis. Theseus. Espoo: Laurea (in Finnish).
- Huhtala, R. & Kauppila, P. (2011). VIRVE ja TETRAsim-koulutusympäristö — esittelyvideo. Thesis. Theseus. Espoo: Laurea (in Finnish).
- Hult, T. (2012). Turvallisuus- ja pelastusviranomaisten ICT-järjestelmien kehittäminen ja integraatio. Thesis. Theseus. Espoo: Laurea (in Finnish).
- Husso, J. (2013). Autonominen videokuvan siirtoon soveltuva tietoverkkoratkaisu viranomaisajoneuvoihin. Thesis. Theseus. Espoo: Metropolia (in Finnish).
- Häyrinen, V. (2013). Ajoneuvon päivittäiskäyttöprosessit. Thesis. Theseus. Espoo: Laurea (in Finnish).
- Iltanen, L. (2012). Taulutietokoneet ja älypuhelimet lääkärin työssä. Thesis. Theseus. Espoo: Laurea (in Finnish).
- Jokitalo, E. & Pohjola, H. (2011). VIRVE-päätelaitteen käytön osaamisen kehittyminen simulaatio-opetuksen avulla. Thesis. Theseus. Espoo: Laurea (in Finnish).
- Jutila, T. (2011). Sormenjälkitunnistus poliisin kenttäolosuhteissa. Thesis. Theseus. Espoo: Laurea (in Finnish).
- Järvinen, J-H. (2010). PATJAsta VITJAan; Poliisiasia-in tietojärjestelmän kokonaisuudistus. Thesis. Theseus. Espoo: Laurea (in Finnish).
- Kirstinä, T. & Lehtinen, S. (2012). Virve-puhelin sairaanhoitajan työvälineenä päivystys-alueella. Thesis. Theseus. Espoo: Laurea (in Finnish).
- Laakso, J. & Leino, H-H. (2011). TETRA-radioverkkojärjestelmän turvallisuuden tutkimus teknisen vertailun ja riskianalyysin avulla. Thesis. Theseus. Espoo: Laurea (in Finnish).
- Lehto, J. (2012). Pelastustoiminnan parantaminen katvealueella sekä pilvipalveluiden hyödyntäminen pelastustoiminnassa: suunnittelututkimus. Master thesis. Theseus. Espoo: Laurea (in Finnish).
- Lyytikkä, E. (2012). Lainsäädännön vaikutus lokienhallintajärjestelmän vaatimusmäärittelyyn: tapaustutkimus julkisesta terveydenhuollosta. Master thesis. Theseus. Espoo: Laurea (in Finnish).
- Maijala, M. & Markkanen, J (2012). Sosionomiopiskelijoiden Virve-koulutuksen kehittäminen. Thesis. Theseus. Espoo: Laurea (in Finnish).
- Nordling, R. & Pollari, A. (2012). Päivystysalueen Virve-vastaavien näkemyksiä Virven käytöstä. Thesis. Theseus. Espoo: Laurea (in Finnish).

Ofem, P. (2011). Investigating the Role of Service Oriented Architecture as an Enabler of ICT Integration and Optimization in Public Protection and Disaster Relief Services - A Case Study of Medical Emergency Services in Finland. Master Thesis. University of the West of Scotland, School of Computing.

Penttinen, J. (2013). Eri tietoturvaluokan palveluympäristöjen käyttö samalla päätelaitteella. Master thesis. Theseus. Espoo: Laurea (in Finnish).

Pullinen, M-J. (2012). Kriittisten tietojärjestelmien suojaaminen kyberuhilta. Master thesis. Theseus. Espoo: Laurea (in Finnish).

Savolainen, S. (2013). Liikkuvan kuvan siirtäminen poliisin tilannejohdon käyttöön piiritystilanteessa. Thesis. Theseus. Espoo: Laurea (in Finnish).

Roisko, V. (2014). Usability evaluation of TETRA mobile radio in Public Protection and Disaster Relief (PPDR) vehicles. Master Thesis. Espoo: Aalto University (In Press).

Sorsa, E. & Santos, R. (2011). Kanta-Hämeen pelastuslaitoksen toimialueiden Forssan ja Hämeenlinnan potilastyytyväisyys ensihoitopalveluiden laatuun. Thesis. Theseus. Hyvinkää: Laurea (in Finnish).

Telkki, T. (2012). Ensihoitokertomuksen käytettävyys sairaalan päivystyspoliklinikalla. Thesis. Theseus. Espoo: Laurea (in Finnish).

Tikanmäki, I. (2011). Possibilities to operational use of Remotely Piloted Aircrafts in Finland. Master thesis. Theseus. Espoo: Laurea.

Timonen, T. (2013). RFID -tekniikan hyödyntäminen poliisin toimintavarmuuden varmistamiseksi: Case poliisipartio. Master thesis. Theseus. Espoo: Laurea.

Ukil, E. (2013) Field testing for verifying a multichannel data communication concept for emergency vehicles. Thesis. Espoo: Laurea.

Urpila, T. (2012). Sopimuspälokuntien pelastusajoneuvojen sähkötekniiset laitteet ja järjestelmät. Thesis. Theseus. Espoo: Laurea (in Finnish).

Vilpas, M. (2012). Javan soveltuvuus DSIP-reititysjärjestelmän asetusmuokkaimen luontiin. Thesis. Theseus. Espoo: Laurea (in Finnish).

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